EA 1431

Fraser River White Sturgeon

An annotated bibliography and review of data sources

for

BC Fisheries
Victoria, BC

23 April 2001

105-04431/

EA 1431

Fraser River White Sturgeon

An annotated bibliography and review of data sources

by

T. C. Nelson, B. E. Baxter, and A. C. Blakley

LGL Limited environmental research associates
9768 Second Street
Sidney, BC V8L 3Y8

for

BC Fisheries
Victoria, BC

23 April 2001

TABLE OF CONTENTS

LIST OF TABLES II

LIST OF FIGURES II

LIST OF APPENDICES II

EXECUTIVE SUMMARY III

INTRODUCTION 1

- STUDY AREA 4

ANNOTATED BIBLIOGRAPHY 15

RAW DATA SOURCES 51

- COMMERCIAL CATCH DATA 51
- SPORT CATCH DATA 53
- FIRST NATIONS CATCH DATA 54
- TEST FISHERY DATA 55
- GENERAL STUDIES DIRECTED AT STURGEON 59

ACKNOWLEDGEMENTS 64

REFERENCES 65

LIST OF TABLES

Table 1. Summary of references for Fraser River white sturgeon, by reference number (in this document), category (topic, focus), and fishery (if applicable).

LIST OF FIGURES

Figure 1. Map of the Fraser River and MELP Region Boundaries.

LIST OF APPENDICES

Appendix A. Summary of locations, contacts, and information gathered for the Fraser River white sturgeon document.

EXECUTIVE SUMMARY

This document provides a compilation of references and data sources for white sturgeon (*Acipenser transmontanus*) within the Fraser River watershed[1]. Several government and non-government fisheries professionals were contacted to obtain references on Fraser River white sturgeon. Where possible, relevant information in the form of hardcopy reports and electronic data were gathered and evaluated. The document presents a tabular summary of all references cited; this table indicates the specific topic or focus of each reference (categories include life history, juvenile, adult, population, management plans, etc), and specifies if the reference is associated with a specific fishery (sport, First Nations, commercial, etc). An ANNOTATED BIBLIOGRAPHY section presents an informative abstract or reference summary for each reference. For references that include data directly relevant to Fraser River white sturgeon, a RAW DATA SOURCES section presents a thorough description of each raw data source. Each raw data source is described using the following criteria: data source, data location, contact person, data format, data range (years), and data reliability (where applicable). Where applicable, recommendations are provided regarding the potential additional use and utility of the data. This document also provides a REFERENCES section of all literature and data sources cited (presented in alphabetical order). Copies of all electronic data files, and the document report files, are provided on CD.

[1] Data sources for the Nechako River are not included in this document. A separate bibliography on Nechako River white sturgeon was in preparation at the time this document was being prepared.

INTRODUCTION

In December 2000 BC Fisheries (a division of Ministry of Food, Agriculture and Fish), Victoria, BC contracted LGL Limited (Sidney, BC) to compile all existing literature references and data sources for white sturgeon in the Fraser River, British Columbia into a reference document. The purpose of this document is to provide an easily accessible list of references and data sources that can be used for future management planning and status evaluations of white sturgeon in the Fraser River watershed. Several government and non-government fisheries professionals were contacted to obtain references on Fraser River white sturgeon. Where possible, relevant information in the form of hardcopy reports and electronic data were gathered and evaluated. In addition, online searches of the WAVES, UVIC, UBC, and SFU libraries were conducted.

The document presents a tabular summary (Table 1) of all references cited. Table 1 (ordered alphabetically by citation) indicates if raw data is available, and the general topic or focus of each reference. The specific topic/focus categories are:

Life History:
Reports or datasets that include information on the life history of Fraser River white sturgeon (i.e., growth, size at age, reproduction, feeding, distribution, etc.)

Spawning:
Reports or data sets that include information regarding Fraser River white surgeon spawning behavior, locations, etc.

Adult:
Reports or datasets that include information regarding the adult phase of Fraser River white sturgeon.

Juvenile:
Reports or data sets that include information regarding the juvenile phase of Fraser River white sturgeon.

Habitat:
Reports or data sets that include information regarding Fraser River white sturgeon habitat (requirements, issues, etc.).

Genetics:
Reports or data sets that include information regarding genetic information for Fraser River white sturgeon.

Contaminant:
Reports or data sets that include information regarding contaminant studies or analyses that are linked to Fraser River white sturgeon and their habitat.

Movement/Distribution:
Reports or data sets that include information regarding the movements, migrations, and distribution of Fraser River white sturgeon.

Population:
Reports or data sets that include information regarding population or abundance information of Fraser River white sturgeon.

Tagging Studies:
Reports or data sets that include information resulting from tagging or tag/recapture studies of Fraser River white sturgeon.

Management Plans:
Reports or data sets that include information used for the purpose of management or regulation of Fraser River white sturgeon.

General Interest:
Reports or data sets that include information of a general nature regarding of Fraser River white sturgeon.

In addition, Table 1 specifies if a reference is associated with a specific fishery:

Sport:
Reports or data sets that include information regarding the sport/recreational fishery for Fraser River white sturgeon.

First Nations:
Reports or data sets that include information regarding the First Nations fishery for Fraser River white sturgeon.

Commercial:
Reports or data sets that include information regarding the capture of Fraser River white sturgeon in either directed or non-directed commercial fisheries.

Test Fishery:
Reports or data sets that include information regarding the capture of Fraser River white sturgeon in test fishery programs.

Users are encouraged to use Table 1 as a starting point for determining which references or data sources are applicable for their specific needs. For example, if a user is specifically interested in references or data that provide information on Fraser River white sturgeon spawning, a quick check in Table 1 for all references under the category "Spawning" would indicate which references contain information on this topic.

Also included in Table 1 (for each citation) are unique reference numbers (annotated bibliography reference number and raw data reference number, if applicable). These reference numbers provide an efficient means of locating references within the document and, for the raw data sources, specific electronic data files on the CD.

The ANNOTATED BIBLIOGRAPHY section presents a citation for each reference (literature and data references, ordered alphabetically) as well as annotated bibliography reference numbers. A report abstract (from original document) or reference summary (contractors interpretation) is provided for each reference.

All reference sources were reviewed for raw data relevant to Fraser River white sturgeon. This document provides a RAW DATA SOURCES section that presents a thorough description of each raw data source. These data sets are categorized into the following groups:

Commercial Catch Data
Sport Catch Data
First Nations Catch Data
Test Fishery Data
General Studies Directed at Sturgeon

A unique raw data reference number is assigned to each raw data source. Where applicable, recommendations are provided regarding the potential additional use and utility of the data. A data box is provided for each raw data reference, and provides the following criteria:

Data Source
Data Location
Contact Person
Data Format
Data Range (years)
Data Reliability (where applicable)

Data Reliability is ranked on a scale from poor to excellent and is a subjective assessment based upon consistency of the data, time span of the data, and accuracy of the data. Please note that the subjective reliability assessments assigned to data sets in this document may not reflect the "true" quality or reliability of these data, and are provided in this document as a guide only.

This document also provides a REFERENCES section of all literature and data sources cited (presented in alphabetical order).

Study Area

The Fraser River watershed drains an area of approximately 250,000 km^2 and is located in south central BC (Figure 1). The Ministry of Environment, Lands and Parks (MELP) uses regional boundaries to separate the Fraser River into specific management regions:

Region 2	the lower Fraser River mainstem up to Spuzzum
Region 3	the Fraser River mainstem between Spuzzum and Gang Ranch including Seton and Anderson Lakes and Kamloops Lake
Region 5	the Fraser River mainstem between Gang Ranch and the inflow of the Nazko River, including the Quesnel River and Quesnel Lake
Region 7	the Nazko River from Cheslatta Falls to Prince George and the Fraser River, the Tachie, Middle and Stuart rivers draining into the Nechako River, and the Fraser mainstem between the Cottonwood and McGregor rivers.

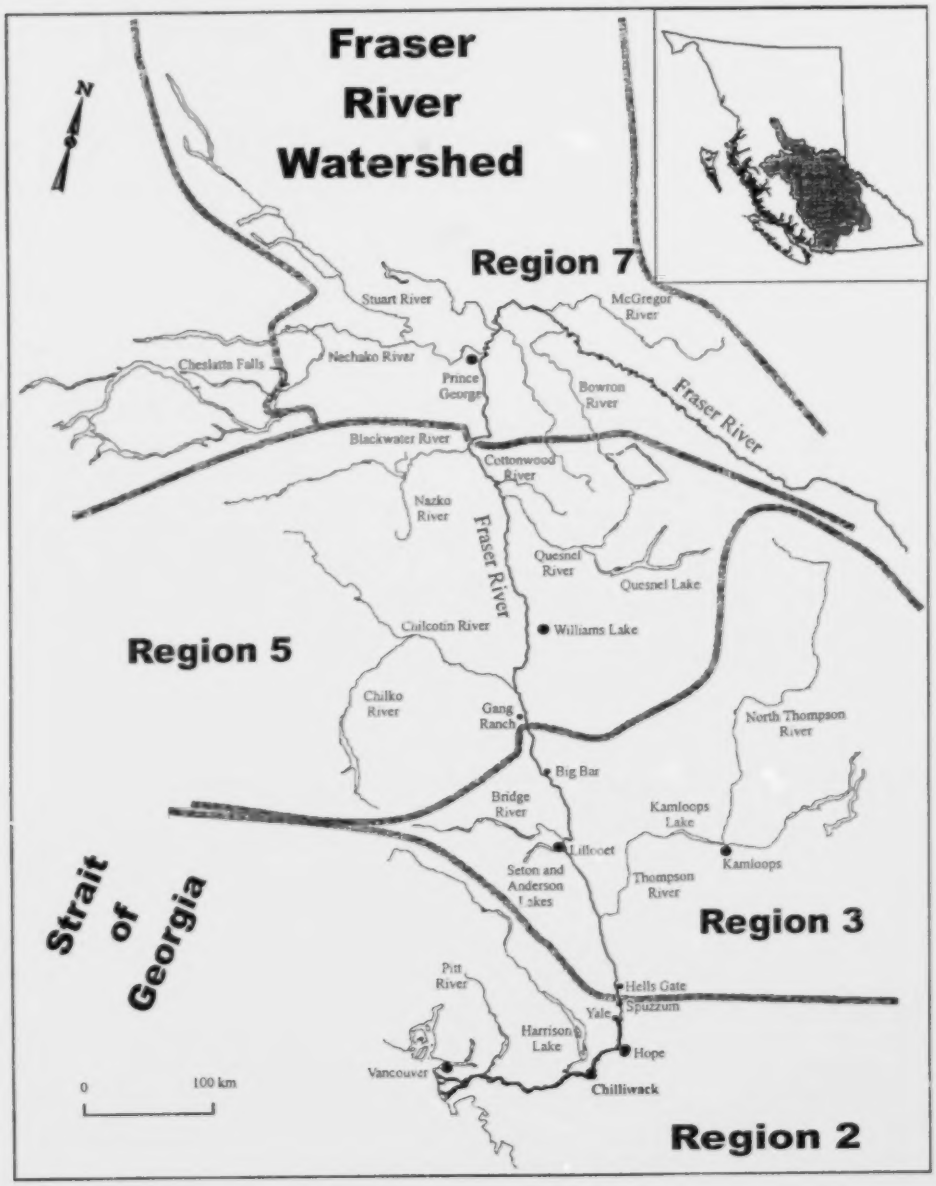

Fig 1. Map of Fraser River and MELP Region boundaries

Table 1. Summary of references for Fraser River white sturgeon, by reference number (in this document), category (topic, focus), and fishery (if applicable).

Annotated Bib. Ref#	Raw Data Ref#	Reference	Raw Data Available	Life History	Spawn	Adult	Juvenile	Habitat	Genetics	Contam-inant	Move-ment/ Distrib-ution	Popul-ation	Tagging Studies	Manage-ment Plans	General Interest	Sport catch	First Nations	Commer-cial	Test Fisheries
1		Bartley et al. 1985				x			x										
2		BC Ministry of Environment 1990												x			x	x	
3		BC Ministry of Environment 1991		x										x		x	x	x	
4		Bennett et al. 1998					x	x											
5		Bratty et al. 1998														x			
6		Brown et al. 1992[a]							x										
7		Brown et al. 1992[b]							x										
8		Brown et al. 1993							x										
9		Dixon 1986		x		x					x		x	x		x	x		
10	21	Echols 1995a	x								x		x	x		x	x	x	
11		Echols 1995b												x					
12		Echols 1995c		x							x			x		x		x	
13		ECL Envirowest								x	x		x						

Annotated Bib. Ref#	Raw Data Ref#	Reference	Raw Data Available	Life History	Spawn	Adult	Juvenile	Habitat	Genetics	Contaminant	Movement/ Distribution	Population	Tagging Studies	Management Plans	General Interest	Sport catch	First Nations	Commercial	Test Fisheries
		Consultants Ltd 1990																	
14		ECL Envirowest Consultants Ltd 1992								x	x		x						
15		Edmonson et al. 1993		x															
16		EVS Environment Consultants 1998		x		x	x			x	x								
17		Glavin 1994													x				
18		Halsey et al. 1994						x						x		x			
19		Hamilton 1996													x				
20		Hanson et al. 1992		x				x						x					
21		Hart 1973		x							x							x	
22	5	Inglis and Rosenau 1994	x													x			
23		Johnston et al. 1975								x									
24		Laidlaw and Rosenau 1998		x	x	x		x		x									
25		Lane 1985													x				
26		Lane 1991		x				x			x	x							
27		Lane and Rosenau		x			x	x			x			x					

Annotated Bib. Ref#	Raw Data Ref#	Reference	Raw Data Available	Life History	Spawn	Adult	Juvenile	Habitat	Genetics	Contam-inant	Move-ment/ Distrib-ution	Popul-ation	Tagging Studies	Manage-ment Plans	General Interest	Sport catch	First Nations	Commer-cial	Test Fisheries
		1995																	
28		Lord 1866													x				
29	8	Macdonald 1987	x														x		
30	9	Macdonald 1988	x														x		
31	10	Macdonald 1989	x														x		
32	11	Macdonald 1990	x														x		
33	12	Macdonald 1991	x														x		
34	13	Macdonald 1992	x														x		
35		MacDonald et al. 1997								x									
36		Margolis and McDonald 1986		x															
37		McAdam 1995		x		x													
38		McDonald et al. 1987				x					x		x						
39		McDonald et al. 1989				x					x		x						
40		Nelson 1997									x								
41		Nelson et al. 1999							x										
42		Northcote 1974		x															
43		Northcote et								x									

Annotated Bib. Ref#	Raw Data Ref#	Reference	Raw Data Available	Life History	Spawn	Adult	Juvenile	Habitat	Genetics	Contam-inant	Move-ment/ Distrib-ution	Popul-ation	Tagging Studies	Manage-ment Plans	General Interest	Sport catch	First Nations	Commer-cial	Test Fisheries
		al. 1975																	
44		Palermo and Thompson 1999[a]														x			
45		Palermo and Thompson 1999[b]														x			
46		Palermo and Thompson 2000														x			
47		Parks 1978																x	
48	23	Perrin et al. 1999	x	x	x	x	x	x			x		x						
49	25	Perrin 2000	x	x				x											
50	26	Perrin and Shaw 2000	x					x			x		x						
51	24	Perrin et al. 2000[a]	x		x	x	x	x			x		x						
52	27	R. L. & L. Environmental Services Ltd. 1996 (1995 data report)	x	x		x	x	x			x	x	x						
53	27	R. L. & L. Environmental Services Ltd. 1997[a] (Region 2 1996)	x	x	x	x	x	x			x	x	x						
54	27	R. L. & L. Environmental Services	x	x		x	x	x			x	x	x						

Annotated Bib. Ref#	Raw Data Ref#	Reference	Raw Data Available	Life History	Spawn	Adult	Juvenile	Habitat	Genetics	Contam-inant	Move-ment/ Distrib-ution	Popul-ation	Tagging Studies	Manage-ment Plans	General Interest	Sport catch	First Nations	Commer-cial	Test Fisheries
		Ltd. 1997[b] (Region 3 1996)																	
55	27	R. L. & L. Environmental Services Ltd. 1997[c] (Region 7 1996)	x	x	x	x	x	x			x	x	x						
56	27	R. L. & L. Environmental Service Ltd. 1998[a] (Region 2 1997)	x	x		x	x	x			x	x	x						
57	27	R. L. & L. Environmental Services Ltd. 1998[b] (Region 3 1997)	x	x		x	x	x			x	x	x						
58	27	R. L. & L. Environmental Services Ltd. 1998[c] (Region 5 1997)	x	x		x	x	x			x	x	x						
59	27	R. L. & L. Environmental Services Ltd. 1998[d] (Region 7 1997)	x	x	x	x	x	x			x	x	x						

Annotated Bib. Ref#	Raw Data Ref#	Reference	Raw Data Available	Life History	Spawn	Adult	Juvenile	Habitat	Genetics	Contam-inant	Move-ment/ Distrib-ution	Popul-ation	Tagging Studies	Manage-ment Plans	General Interest	Sport catch	First Nations	Commer-cial	Test Fisheries
60	27	R. L. & L. Environmental Services Ltd. 1999[a] (Region 2 1998)	x	x		x	x	x			x	x	x						
61	27	R. L. & L. Environmental Services Ltd. 1999[b] (Region 3 1998)	x	x		x	x	x			x	x	x						
62	27	R. L. & L. Environmental Services Ltd. 1999[c] (Region 5 1998)	x	x							x	x	x						
63	27	R. L. & L. Environmental Services Ltd. 1999[d] (Region 7 1998)	x	x	x	x	x	x			x	x	x						
64	27	R. L. & L. Environmental Services Ltd. 2000[a] (Region 3 1999)	x	x				x			x	x	x						
65	27	R. L. & L. Environmental Services	x	x				x			x	x	x						

Annotated Bib. Ref#	Raw Data Ref#	Reference	Raw Data Available	Life History	Spawn	Adult	Juvenile	Habitat	Genetics	Contam-inant	Move-ment/ Distrib-ution	Popul-ation	Tagging Studies	Manage-ment Plans	General Interest	Sport catch	First Nations	Commer-cial	Test Fisheries
		Ltd. 2000[b] (Region 5 1999)																	
66	27	R. L. & L. Environmental Services Ltd. 2000[c] (Region 7 1999)	x	x	x	x	x	x			x	x	x						
67	27	R. L. & L. Environmental Services Ltd. 2000[d] (Comprehensive Report 1995-1999)	x	x	x	x	x	x	x		x	x	x						
68		Richardson et al. 2000		x								x							
69		Rosenau and Usher 1992												x		x			
70		Rosenau 1994												x					
71	14	Schubert 1984	x														x		
72	15	Schubert 1985	x														x		
73	16	Schubert 1986	x														x		
74	6	Schubert 1992a	x													x			
75		Schubert 1992b														x			
76		Scott and		x	x	x	x	x			x					x		x	

Annotated Bib. Ref#	Raw Data Ref#	Reference	Raw Data Available	Life History	Spawn	Adult	Juvenile	Habitat	Genetics	Contam-inant	Move-ment/ Distrib-ution	Popul-ation	Tagging Studies	Manage-ment Plans	General Interest	Sport catch	First Nations	Commer-cial	Test Fisheries
		Crossman 1973																	
77		Semakula 1963		x	x	x								x					
78	2	Semakula and Larkin 1968	x	x		x								x				x	
79		Swiatkiewic z 1981												x					
80		Swiatkiewic z 1992									x		x			x			
81		Veinott et al. 1999		x		x	x				x								
82		Walter et al. 1998														x			
83		West, G. A. 1968														x			
84		West, G. A. 1969														x			
85		West, G. A. 1970														x			

ANNOTATED BIBLIOGRAPHY

(1) Bartley, D. M., G. A. E. Gall, and B. Bentley. 1985. Preliminary description of the genetic structure of white sturgeon, *Acipenser transmontanus*, in the Pacific Northwest. Binkowski, F. P. and Doroshov, S. I. editors. North American sturgeons: biology and aquaculture potential. Papers from a symposium on the biology and management of sturgeon, held during the 113th annual meeting of the American Fisheries Society at Milwaukee, WI, Aug. 16-20, 1983, p. 105-109. Dordrecht, Netherlands, Dr. W. Junk Publishers.

SUMMARY: This is a preliminary report on the use of starch gel electrophoresis to assess the genetic structure of four populations of white sturgeon. At least one variant allele was found at seven of nineteen loci studies. The preliminary data identify significant allelic variation among the populations of white sturgeon. Average heterozygosity ranged from 4.9 to 6.9% in three populations with ocean access, while a landlocked population from the Kootenai River, had a value of only 1.4%.

(2) BC Ministry of Environment. 1990. White Sturgeon Working Group. Proceedings of the White Sturgeon Working Group meeting, June 20, 1990, Malaspina College, BC, p. 1-12.

SUMMARY: A summary detailing the discussions held at the White Sturgeon Working Group Meeting (June 20th, 1990 – 9:30 am, Malaspina College Boardroom). The purpose of this workshop was to discuss that state of the white sturgeon population in the lower Fraser River (Hells Gate to the mouth), and to discuss and make recommendations on the needs for research and possible future enhancement of the species.

A brief review of the present catch and effort data, supplied by the Department of Fisheries and Oceans is included, along with possible research projects. There is some concern that with a relatively constant incidental fishery, an increasing Native food fishery and increasing sport fishery pressure, the white sturgeon population could decline.

(3) BC Ministry of Environment. 1991. White sturgeon (*Acipenser transmountanus*): a management plan for the fisheries program. 18 p. + appendices.

SUMMARY: Information regarding white sturgeon sport fishery in BC is sparse and largely anecdotal or, in most cases, non-existent. Regional documentation of sturgeon use commercially/and or recreationally is presented as background for this Provincial Sturgeon Management Plan.

Management objectives proposed in the Sturgeon Management Plan reflect the strategic objectives that have been developed for the Fisheries Program. These objectives are: 1) conserve wild stocks, 2) protect and manage sturgeon habitat, 3) serve the public interest. The Sturgeon Management Committee discusses a number of recommendations based on these objectives in order to secure the future management of white sturgeon in British Columbia.

(4) Bennett, W. R., G. Edmondson, E. D. Lane, and M. Rosenau. 1998. Juvenile white sturgeon (*Acipenser transmontanus*) habitat and distribution in the lower Fraser River, downstream of Hope, BC, Canada. Submitted to Can. J. Fish. Aquat. Sci. 23 p.

ABSTRACT: Based on CPUE, the juvenile population of white sturgeon (*Acipenser transmontanus*) in the lower Fraser River decreased between 1985 and 1993. In addition, catch per unit effort declined from June to August during the day but increased from 2.6 to 9.2 at night in July in Nicomen Slough only. All but three sturgeons were captures in the June to August period with one taken in April/May and two taken in the September to mid-November period. Sturgeon were caught more frequently in summer and salmonid smolts/adults were caught more frequently in spring/fall. Suckers (Catastomus so,), peamouth chub (*Mylocheilus caurinus*), shiners (*Richardsonius balteatus*), squawfish (*Ptychocheilus oregonensis*) and crappie (*Pomoxis nigromaculatus*) showed little difference in seasonal catch fishery. From 1985-1993 a total of 1867 white sturgeon were captured with gill nets in thirty-five sites in the lower Fraser River from Deas Slough (near the mouth, river 4 km) to Bristol Slough at Hope (immediately downstream of the Fraser Canyon, river km 200). The greatest numbers of sturgeon were caught in Nicomen Slough, Hatzic Slough, and Big Eddy Backwater when temperatures ranged from 15˚C to 20˚C. Nicomen Slough, lower Hatzic Slough, Big Eddy Backwater all had areas of water deeper that 5 m and current that was not unidirectional. Turbidity ranged from 1.5 Nephelometric Units (NTU's) to 67.0 NTU in general and the substrate in most sites was made up of fine sediments, fine sand, silt and clay. Stomach contents were found to be mysid shrimp (Mysidacea), midge larvae (Chironomidae) and peamouth chub (*Mylocheilus caurinus*).

(5) Bratty, J. M., R. E. Diewert, J. Irvine, V. Palermo, and A. S. Thompson. 1998. Angler effort and catch in the 1995 lower Fraser River sport fishery. Can. Manuscr. Rep. Fish. Aquat. Sci. 2469: 36 p.

ABSTRACT: The lower Fraser River mainstem recreational fishery was assessed annually by creel survey from 1985 to 1990. Assessment of the fishery was suspended until 1995 when, once again, an access point/over flight hybrid survey design was utilized to evaluated angler characteristics and estimate catch. The survey focused on assessing angler effort and distribution and estimating the harvest and release of chinook (*Oncorhynchus tshawytscha*), sockeye (*O. nerka*) and pink (*O. gorbuscha*) salmon in the study area. A total of 6, 171 angler interviews and 32 over flights were conducted between June 3 and September 29. An estimated 374, 510 angler hours were expended during the survey, resulting in the harvest of 5,501 adult chinook, 1,620 jack chinook, 6,376 sockeye and 22,88 pink salmon. Estimated releases totaled 420 adult chinook, 111 jack chinook, 3,312 sockeye and 73,160 pink salmon.

This important recreational fishery has grown since the last series of surveys, as evidence by the increase in angler effort and harvest of chinook. The harvest and release of sockeye and pink salmon was also considerable in 1995 but no data is available for comparison from previous years. Compared to previous surveys, angler distribution in the lower Fraser River during 1995 was more concentrated between the Sumas and Coquihalla rivers.

The report concludes with recommendations for the future management and assessment of the fishery. Estimated sturgeon releases for Regions 3 and 4 of the lower Fraser River totaled 8 in July and 183 in August, 52 in September, for a total of 243.

(6) Brown, J. R., A. T. Beckenbach, and M. J. Smith. 1992a. Mitochondrial DNA length variation and heteroplasmy in populations of white sturgeon (*Acipenser transmontanus*). Genetics 132: 221-228.

ABSTRACT: Southern blot analysis was used to quantify the extent of mtDNA D-loop length variation in two populations of white sturgeon, Acipenser transmontanus. Over 42% of individuals were heteroplasmic for up to six different mtDNA length variants attributable to varying copy numbers of an 82-bp repeat sequence. Chi-square analyses revealed that the frequencies of length genotypes and the incidence of heteroplasmy were significantly different between the Fraser and Columbia River sturgeon populations but not between restriction site haplotypes. Heteroplasmic fish have, on average, higher copy number than homoplasmic fish. Forty-five of 101 homoplasmic individuals carry only a single copy of the repeat, while none of the 73 heteroplasmic fish has the single repeat as the predominant variant. On the basis of differences in frequency distributions of copy number within and between fish, we suggest that (1) heteroplasmy is maintained by high recurrent mutation of multiple copy genomes, favoring increased copy number and (2) the mutation pressure toward higher copy number heteroplasmy is partially offset by selection to reduced genome size and segregation to the homoplasmic condition.

(7) Brown, J. R., A. T. Beckenbach, and M. J. Smith. 1992b. Influence of Pleistocene glaciations and human intervention upon Mitochondrial DNA diversity in white sturgeon (*Acipenser transmontanus*) populations. Can. J. Fish. Aquat. Sci. 49: 358-367.

ABSTRACT: The influence of recent genetic bottlenecks on two Northwest Pacific populations of white sturgeon (*Acipenser transmontanus*) was studied using restriction enzyme site differences in mitochondrial DNA (mtDNA). A total of 10 mtDNA genotypes were detected in 178 sturgeon from the Columbia and Fraser rivers. Nearly 61% of individuals from both rivers had a common genotype. However, one genotype was found only in the Fraser River. Geographical sub structuring was not evident in the phylogenetic analysis. The Columbia River, a Pleistocene refugium, is suggested as the source of founders for the Fraser River following the last glacial recession, about 10 000 - 12 000 yr ago. MtDNA genotypic frequencies were significantly different between the rivers. Estimates of mtDNA (h) and nucleotide (π) diversity were consistently higher for the recently colonized Fraser River compared with the Columbia River refugium. This condition is the reverse of all known studies of mtDNA diversity between refugium and colonized animal populations. Recent overexploitation and habitat destruction are suggested as a severe genetic bottleneck that has reduced mtDNA diversity in Columbia River sturgeon

(8) Brown, J. R., A. T. Beckenbach, and M. J. Smith. 1993. Intraspecific DNA sequence variation of the mitochondrial control region of white sturgeon (*Acipenser transmontanus*). Molecular Biology and Evolution 10(2),: 326-341.

ABSTRACT: Intraspecific sequence variation in the D-loop region of mtDNA in white sturgeon (Acipenser transmontanus), a relict North American fish species, was examined in 27 individuals from populations of the Columbia and Fraser Rivers. Thirty-three varied nucleotide positions were present in a 462-nucleotide D-loop sequence, amplified using the polymerase chain reaction. Bootstrapped neighbor-joining and maximum-parsimony trees of sequences from 19 haplotypes suggest that the two populations have recently diverged. This is consistent with the hypothesis that the Columbia River, a Pleistocene refugium habitat, was the source of founders for the Fraser

River, after the last glacial recession. On the basis of a divergence time of 10-12 thousand years ago, the estimated substitution rate of the white sturgeon D-loop region is $1.1\text{-}1.3X10^{-7}$ nucleotides/ site/ year, which is comparable to rates for hyper variable sequences in the human D-loop region. Furthermore, the ratio of mean percent nucleotide difference in the D-loop (2.27%) to that in whole mtDNA (0.54%, as estimated form restriction-enzyme data) is 4.3, which is similar to the fourfold-to-fivefold-higher substitution rate estimated for the human D-loop. The high nucleotide substitution rate of the hypervariable region indicates that the vertebrate D-loop has potential as a genetic marker in molecular population studies.

(9) Dixon, B. M. 1986. Age, growth and migration of white sturgeon in the Nechako and upper Fraser Rivers of British Columbia. BC Ministry of Environment, Fisheries Technical Circular No. 70: 27 p.

ABSTRACT: Data from three-year old radio-tagging study of white sturgeon (Acipenser transmontanus) in the Nechako River was consolidated with all other available information on white sturgeon in the Omineca area. The compiled records were compared with the fisheries literature on this species in order to identify the major gaps in our knowledge of the resident sturgeon population and to facilitate a review of the management of the Omineca sturgeon.

The information available on Omineca sturgeon showed little discrepancy with sturgeon populations elsewhere, except that this northerly population appears to grow slower and mature later than coastal or southerly populations. The length to weight relationship of white sturgeon suggests that more efficient utilization of the weight potential could be achieved by increasing the minimum size limit of 100 cm by 20 cm to 120 cm. Significant weight gain does not occur until an individual reaches about 120 cm fork length, which is at about age 21 for Omineca white sturgeon. The maximum size limit of 200 cm is necessary in order to maintain a spawning stock "reservoir". Total harvest levels should be regulated conservatively owing to the slow growth exhibited by this species and the consequential slowness of the population to recover from over harvest.

(10) Echols, J. C. 1995a. Fraser River white sturgeon long-term management: objectives, strategies and uncertainties. Masters Thesis. Dept. Resource and Environmental Studies, Univ. British Columbia, Vancouver, B. C. 87 p.

ABSTRACT: The sharp decline of Fraser River white sturgeon (*Acipenser transmontanus*) in the late 1800s was the result of large catches in response to a market demand for caviar and smoked sturgeon. After a long period of indifference, the British Columbian public became concerned with the lack of white sturgeon information and probable large stock decline during the summer of 1993 with the discovery of several large white sturgeon carcasses. In September of 1994, a "catch and release" policy was implemented and met with mixed reactions to harvest favored the current cautious approach to limit retention. The objectives of this thesis are to: clarify objectives and structure strategies for white sturgeon management; analyze uncertainty under these strategies in s stock harvest model; and discuss the role of uncertainty in management decisions and structure. It must be recognized that no perfect management solution exits. However, structuring fisheries management objectives and exploring uncertain stock reactions must be the first, crucial step to success. By simulating future events based on past stock reaction patterns, various white sturgeon harvest strategies and their ability to achieve management objectives is evaluated. This study focuses on how Fraser River white sturgeon might react under various harvest strategies designed to achieve management objectives by treating recruitment

stochastically in a delay-difference model as unpredictable "states of nature." Results indicate that the probability of over harvest changes surprisingly little. This may help managers and stakeholders to assess their roles in the management process. Thus, uncertainty was quantified to show that the role of risk assessment in developing strategies to achieve long-term objectives for Fraser River white sturgeon is important. While theoretical arguments are not too convincing, in practice, white sturgeon may be suitable for unusual harvest management initiatives such as individual quotas. Some hardcopy and electronic files available, please refer to raw data reference 20 in "Raw Data Sources" section.

(11) Echols, J. C. 1995b. Review of Fraser River white sturgeon (*Acipenser transmontanus*). Fraser River Action Plan, Fishery Management Group, and Canada Dept. of Fisheries and Oceans. 33 p.

SUMMARY: Prior to 1985, data collection on the Fraser River white sturgeon was limited, but has increased since that time. Currently, the provincial Ministry of Environment, Lands and Parks (MELP) is funding biological studies on the Fraser River white sturgeon, with the study area extending from Yale (above Hope) to upper reaches near Prince George (Fig. 1). In an effort to strengthen the research and management initiatives on Fraser River white sturgeon, MELP and the federal Department of Fisheries and Oceans (DFO) have agreed to work jointly on improving the health of the white sturgeon stocks.

Given the very limited information available on Fraser River white sturgeon, the purpose of this report is to review and summarize existing information, and stimulate development of sturgeon management initiatives within DFO. While much of the scientific information included here is based on white sturgeon populations in the Columbia and Sacramento rivers of the western United States, this information remains useful in addressing the biological and management issues of the Fraser River white sturgeon population.

(12) Echols, J. C. 1995c. Status review of Fraser River white sturgeon (*Acipenser transmontanus*). Draft report. Department of Fisheries and Oceans, Vancouver, BC. 29 p.

SUMMARY: This report is a first step to building and effective co-operative sturgeon management initiative. The purpose of this report is to assess the status of white sturgeon information by reviewing pertinent literature and briefly analyzing available raw catch and tagging data. Thus, it is possible to identify potential information gaps in the process of developing joint provincial and federal management and research plans for white sturgeon.

(13) ECL Envirowest Consultants Limited. 1990. Fraser River white sturgeon radio tagging and sampling. Progress report to March 31, 1990. Prepared for Ministry of Environment, Fish and Wildlife Branch, Surrey, B.C.

SUMMARY: Little is know about the biology and habitat requirements of the Fraser River white sturgeon (*Acipenser transmontanus*). Studies conducted between 1985 and 1988 suggest a high mortality rate and that the spawning population may be small, particularly for larger fish (over 150 cm). Pollution, habitat loss/ degradation and over harvesting by recreational, incidental commercial and native fisheries are probable causes of the declining numbers of sturgeon. Further assessment of these factors may provide direction in managing Fraser River white sturgeon.

This study was comprised of two components. First, radio tagging was conducted to identify the migratory behaviors and habitat requirements of the sturgeon. Second, a program was established to collect liver and muscle samples that would be analyzed for heavy metals, pesticides, wood preservatives, dioxins/furans and other toxic substances. Pectoral fins rays are also being collected for age analysis. Coincident with these studies, the Ministry of Environment is assessing the harvest of sturgeon in the recreational, commercial and native fisheries.

This report summaries the activities and findings of the first year of this two-year project. Monies for this project were received from the Habitat Conservation Fund.

(14) ECL Envirowest Consultants Limited. 1992. Fraser River white sturgeon: radio tracking and tissue sampling. 1989-1992. Report prepared for BC Ministry of Environment, Lands and Parks, Surrey, BC, by ECL Envirowest Consultants Ltd., New Westminster, BC. 15 p. + appendices.

SUMMARY: Few studies have been performed to document the biology, behavior and habitat requirements of the white sturgeon (*Acipenser transmontanus*) that inhabit the lower Fraser River of British Columbia. A recently completed study suggests that the fish are subject to a high mortality rate and that the spawning population may be small, particularly for large fish (over 150 cm in length). Pollution, habitat loss/degradation and over-harvesting by recreational, incidental commercial and native fisheries are probable causes of the declining numbers of sturgeon. Lack of sufficient information regarding the white sturgeon is an obstacle for those responsible for managing this species in the Fraser River.

This study was comprised of two components. First, radio-tagging was conducted to assess the migratory behavior and habitat requirements of the sturgeon. Second, a program was established to collect liver and muscle samples for analysis of dioxins/furans, heavy metals, pesticides/herbicides, and other toxic substances. Pectoral fin rays were collected for age analysis. Concurrent with this study, the Ministry of Environment, Lands and Parks (MOELP) assessed the harvest of white sturgeon in the recreational, commercial and native fisheries. ECL Envirowest Consultants Limited (Envirowest) was retained for two consecutive fiscal years (1989/90 and 1990/91) to conduct the white sturgeon assessments, with funding provided by the Habitat Conservation Fund (HCF). This report also incorporates and discusses data collected both prior to, and subsequent to, that two-year assessment period. Funding for other assessment periods was also provided by HCF.

(15) Edmonson, G. C., Bennett, W. R., and, E. D. Lane. 1993. Aspects of age and growth, size distribution, and validation of aging in white sturgeon, *Acipenser transmontanus*, from the Fraser River, British Columbia. Presented at the Proceedings of the 123rd Annual Meeting of the American Fisheries Society . 15 p.

SUMMARY: During 1985-1987 and 1992, white sturgeon were sampled in the Fraser River for age and growth. Mark and recapture combined with oxytetracycline were used to validate aging using thin sections of the first pectoral ray. Growth rates from the upper river, lower river and laboratory raised fish will be compared. Comparing data from 1985-1987 with 1992 (Nicomen slough), it appears there were more small fish and fewer larger fish in 1992; the reasons for this are uncertain, but the sturgeon fishery has changed quite markedly in this time period.

(16) EVS Environment Consultants. 1998. Review of white sturgeon distribution and life history in the Fraser River with respect to potential impacts from sawmill storm water runoff. Report prepared for Coast Forest and Lumber Association, Vancouver, BC by EVS Environment Consultants, North Vancouver, BC. 18 p.

ABSTRACT: This study was initiated due to concerns over the presence of toxicity in samples of storm runoff from sawmills. In order to formulate an appropriate and cost effective response strategy to reduce the incidence of toxicity, it was first necessary to identify the cause(s) of toxicity. Thus, any treatment or source control action could be focused on the contaminant(s) of interest. The primary contaminants of concern included metals antisapstain chemicals, various organic chemicals (e.g. defoaming agents, oils and grease, etc.) and naturally occurring wood extractives.

One of the elements of the report discusses concern over preliminary research that suggested white sturgeon larvae and fry might be unusually sensitive to DDAC, one of the antisaptains applied frequently at sawmills. Thus, there was concern over whether the distribution of these early life history stages might be overlap the location of sawmills on the lower Fraser River and be at risk from DDAC in storm water discharges. The study was conducted by EVS Environment Consultants with the support of MacMillan Bloedel Research and the Coast Forest and Lumber Association.

(17) Glavin, T. 1994. A ghost in the water. New Star Books. Vancouver, B.C. 78 p.

SUMMARY: Summary of white sturgeon information for the Fraser River, includes history of commercial First Nations and sport fisheries for Fraser River white sturgeon.

(18) Halsey, G., M. Labelle, A. Tautz , and M. Rosenau. 1994. Recovery and restoration of white sturgeon *Acipenser transmontanus* in British Columbia: Fraser and Columbia River watersheds. Report of the White Sturgeon Task Team. 21 p.

ABSTRACT: The white sturgeon, *Acipenser transmontanus*, is restricted primarily to three major watersheds in western North America including the Sacramento- San Joaquin, the Columbia and the Fraser rivers. Since the arrival of the European, numbers of white sturgeon have almost universally declined. In British Columbia, in April 1990, the white sturgeon was listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) at a "vulnerable status" level. In September 1994, the transboundary population of white sturgeon in Kootenay Lake (Columbia River drainage) was listed by the US government under the Endangered Species Act.

Historically, the first major declines were due to over-exploitation by man. Until September 1994, when it was finally closed to sport, commercial, and downriver First Nations, there was harvest by all three fishery sectors on the Fraser River. Recent research has shown white sturgeon to be in decline in this watershed. White sturgeon harvest has also been restricted completely in the Canadian Columbia River. Moreover, human-related habitat degradation is now contributing substantially to the present declines with recruitment in some populations no longer occurring due to impacts from hydroelectric dams. Other impacts may include dredging, dyking, log booming and pollution.

Because of this crisis situation, a clear understanding of white sturgeon in British Columbia is required to manage and protect this species. This document outlines a program to achieve those goals.

(19) Hamilton, G. 1996. Phantom of the Fraser. Canadian Geographic 116(4).

SUMMARY: Focuses on the beleaguered white sturgeon, *Acipenser transmontanus*, on the Fraser River in British Columbia. Devastation brought by over fishing on the sturgeon population; mysterious die-off of mature sturgeons in the summer of 1993; study of the Fraser River sturgeons; peculiar features of sturgeons.

(20) Hanson, D. L., T. G. Cochnauer, J. D. DeVore, H. E. Forner, Jr., T. T. Kisanuki, D. W. Kohlhorst, P. Lumley, G. McCabe, Jr., A.A Nigro, S. Parker, D. Swartx, and A. VanVooren. 1992. White sturgeon management framework plan. Pacific States Marine Fisheries Commission. Portland, OR.

SUMMARY: This paper was prepared by the White Sturgeon Planning Committee to promote and support policies and actions directed at the conservation, development, and management of sturgeon fishery resources of mutual concern to member states throughout the Pacific. In regards to the Fraser River sturgeon stocks, this paper discusses the distribution and habitat use, abundance, status, and productivity and the history of the fishery. Current harvest management goals and studies are also documented along with a list of studies recommended for the future.

(21) Hart, J. L. 1973. Pacific fishes of Canada. Fisheries Research Board of Canada Bulletin 180: 83-84.

SUMMARY: A brief summary on the description, size, recognition, life history, distribution and utilization of white sturgeon in Canada. Semakula and Larkin 1969 are referenced in describing that young white sturgeon in the Fraser River are found in sloughs in the lower reaches. Semakula 1963 is referenced in describing that spawning or spawned-out eulachon is an important food and some sturgeon migrations seem to be associated with eulachon availability. Other prey items include sculpins, sticklebacks, lampreys, youn sturgeon, crayfish, and mollusks. Commercial landings (in tonnes) of Fraser River white sturgeon are summarized in a tabular format from 1880-1970. The peak of the Fraser River commercial fishery was reached in 1897 with a landing of 1,137,700 pounds (516,000 kg) but by 1901 the commercial fishery was all but over.

(22) Inglis, S. D. and M. L. Rosenau. 1994. Non-tidal sturgeon angler fishery on the Lower Fraser River-angler card analysis. Regional Fisheries report LM 241, BC Ministry of Environment, Lands and Parks. 64 p.

ABSTRACT: A very popular sturgeon sport fishery has existed on the Lower Fraser River since the early 1950's. Concern over reports of declining white sturgeon populations in this region has prompted the initiation of several studies. Six years (1985/91) of sturgeon angler card data from non-tidal regions were statistically analyzed for trends in the fishery to provide information on the status of the white sturgeon stocks in this region. The results of this analysis show an increase in the recruitment of angler into the fishery and a decrease in the catch per unit effort (CPUE) of sturgeon over this time period. While the number of sturgeon being caught by anglers has decreased, the estimated harvest rate has increased. Sub legal and legal sturgeon below 150 cm in length made up the majority of the total reported catch. Although sub-legal size sturgeon, by

definition, are to be released there has been a very dramatic decrease in the catch rate of sub-legal sturgeon. Consequently, the mean length of legal size sturgeon has increased as the smaller sturgeon are exploited. Sturgeon often spawn for the first time at 11 years of age or 60 cm in length (sub-legal size) and therefore, reproductive capabilities are reduced as well as the number of new recruits to the fishery. Sturgeon angler behavior was consistent over the six years, with most of the fishing effort occurring during July-Sept. in Zone 2 between Mission Bridge and Harrison River. A very interesting and significant two year cycle was observed in the catch rate of sturgeon over 200 cm in length and the CUPE for fish of the same size. It is possible that this cycle may be linked to the two year pink salmon run of the Fraser River. Further investigation into this phenomena is recommended. Sturgeon populations are very slow growing and are sensitive to over harvesting. The sturgeon of the Lower Fraser River are semi-anadromous and thus cooperation between the tidal and non tidal fishery is necessary to compiling any complete data sets on the sturgeon sport fishery. It is hoped that the database developed from this study will aid in the management and conservation of this species and the white sturgeon fishery. Some hardcopy and electronic files available, please refer to raw data reference 4 in "Raw Data Sources" section.

(23) Johnston, N. T., L. J. Albright, T. G. Northcote, P. C. Oloffs, and K. Tsumura. 1975. Chlorinated hydrocarbon residues in fishes from the lower Fraser River. Technical Report no. 9. Westwater Research Centre. University of British Columbia, Vancouver, B.C. 31 p.

SUMMARY: Concentrations (ppb, wet weight) of aldrin, %- and ϒ-chlordane, heptachlor, lindane, dieldrin, heptachlor epoxide, p,p'-DDT, p,p-DD, p,p-DDE, and PCB's (resembling Aroclor 1254) in the epaxial white muscle tissue of 183 specimens of 12 species of fish taken from the Fraser River downstream of Hope, British Columbia were determined. Aldrin, %- and ϒ-chlordane, heptachlor, lindane were not detected in any fish. Dieldrin was found in trace amounts (< 4 ppb) in two cutthroat trout and white sturgeon from the lower reaches of the river and in a largescale sucker from the upper reaches. Heptachlor epoxide, p,p'-DDT, and p,p'-DDD were found in the low concentrations (up to 86.6 ppb) in about 12 percent of the samples while p,p'-DDE and PCB's were found at higher levels in most of the fish.

Heptachlor epoxide concentrations in the fish samples averaged 2.0 ppb while p,p'-DD and p,p'-DDT averaged <1 ppb respectively. No significant differences in mean concentrations of these compounds among major regions of the river could be shown, in contrast to the results for p,p'-DDE and PCB's where regional or interspecific differences were noted.

Muscle tissue concentrations of p,p'-DDE averaged below 20 ppb for most species, including all the salmonids (salmon, trout, and char). The highest level found in any sample was 1.74 ppm in a large carp from the North Arm. No regional differences in mean concentrations were noted. Significant interspecific differences existed but were not interpretable in terms of trophic position or residency in the river. In all cases, the measured concentrations of DDT and its analogues were well below Canadian Food and Drug Directorate standards from human consumption (5 ppm). PCB's were the organochlorine residues found in greatest concentrations in the muscle tissue of fishes from the lower Fraser River. The mean PCB concentration of all samples was 140.7 ppb (3 ½ times the mean concentrations of DDT and its metabolites) while the maximum was 3.69 ppm. Interspecific differences in PCB levels were not significant but for several species both mean values and incidence of occurrence of detectable residues were higher in the portion of the river adjoining urban Greater Vancouver than further upriver.

Concentrations of p,p'-DDE (or of total DDT) increased with increasing size for largescale sucker, northern squawfish, and rainbow trout. Tissue levels of PCB's did not vary with fish size. PCB and total DDT levels were significantly correlated in rainbow trout and northern squawfish (correlation coefficients of 0.35 and 0.48 respectively).

Chlorinated hydrocarbon residue concentrations in Fraser River fishers are generally very low in comparison to values noted for other regions of North America. The high levels of total DDT and of PCB's found in a few individuals and the higher incidence and mean concentrations of PCB's in fish from the lower reaches of the river suggest that localized loadings of organocholrine compounds may be significant. Certainly further studies on sources and pathways of accumulation of these compounds in the lower Fraser are needed.

(24) Laidlaw, K. A. and M. L. Rosenau. 1998. An assessment of putative white sturgeon spawning habitat in areas impacted by scuffle dredging in the Fraser River: Hope to Mission. BC Ministry of Environment Lands and Parks. Regional Fisheries Report No. LM557: 15 p. + appendices.

ABSTRACT: Over the last 40 years the Fraser River has been scuffle dredged for navigation purposes at specific locations between Mission and Hope in order to allow for the downstream passage of log booms and other marine traffic during periods when high water velocities inhibit the upstream passage of log booms from the ocean. Some of the bottom substrates being dredged may be spawning habitat of the white sturgeon (*Acipenser transmontanus*). In order to assess the possible impacts to white sturgeon habitat and egg incubation, in 1995 the Ministry of Environment, Lands, and Park (MELP) requested that the Public Works and Government Services Canada (PWGSC) undertake an assessment of the physical parameters depth, velocity, and substrate, at three dredging locations. The objective was to compare these data with published Columbia River suitability-of-use curves for depth, velocity, and substrate to determine sturgeon spawning-habitat quality at dredge sites. Based on the suitability-of-use modelling, all three scuffle-dredge sites appear to be adequate for white sturgeon spawning with suitabilities of 1 (most suitable) being observed at these three locations for the depth and velocity parameters. Because the substrate samples collected by PWGSC did not appear to reflect the actual size distribution of the stream bed, six additional substrate samples were taken from the Cheam View dredge site in 1996 using a clamshell dredge, a more comprehensive sampling technique. We found that with the additional samples taken at Cheam View, suitabilitys of 1.0 for substrates were also found at this dredge location. Furthermore, previous MELP studies suggest that ripe white sturgeon are present between Mission and Hope during the spawning period, and thus spawning may take place here as well. Therefore, we conclude that scuffle-dredging may impact on high quality white sturgeon spawning habitat in the Fraser River between Hope and Mission.

(25) Lane, E. D. 1985. A bibliography on the white sturgeon, (*Acipenser transmontanus*) Richardson, 1836. Can. MS Rep. Fish. Aquat. Sci. 1828: 33p.

ABSTRACT: This bibliography lists 224 published and unpublished reports issued prior to January 1985 on the white sturgeon (Acipenser transmontanus Richardson, 1836) from the North American Pacific Coast. Indices to authors localities, and subjects are included.

(26) Lane, E. D. 1991. Status of the white sturgeon, *Acipenser transmontanus*, in Canada. The Canadian Field Naturalist 105: 161-168.

ABSTRACT: Significant populations of White Sturgeon, *Acipenser transmontanus*, are restricted to three rivers in northwestern North America, the Sacramento, Columbia, and Fraser. While this species can and does enter the seawater it is not an obligatory anadromous species. In British Columbia, White Sturgeon are caught by commercial, native and sports fishermen, especially in the lower Fraser River. The present total B.C. catch is likely 30 to 40 tonnes/year. White Sturgeon spend most time in main channel areas but move into sloughs and side channels in summer in response to temperature. The species have been reported to spawn upstream in the Sacramento River at temperatures between 7.8 to 17.8 °C in spring. Fecundity is high (180 000 to 590 000) and eggs are adhesive, hatching in a week at 15°C. Growth rates are variable and appear to be climatically influenced – Columbia fish reach an average of 167 cm in 20 years. White sturgeon are carnivorous, feeding on invertebrates and fish. Limiting factors are uncertain but temperature may be important. The White Sturgeon is the largest freshwater fish in Canada. While present populations appear healthy, the distribution in Canada is restricted to sound and central British Columbia in the Fraser and Columbia Rivers where they are subject to commercial, native, and increasingly popular sport fisheries.

(27) Lane, E. D. and M. Rosenau. 1995. The conservation of sturgeon stocks in the Lower Fraser River watershed. A baseline investigation of habitat, distribution, and age and population of juvenile white sturgeon (*Acipenser transmontanus*) in the lower Fraser River, downstream of Hope, BC. Final report Habitat Conservation Fund Project. 96 p. + appendices.

SUMMARY: This is the final report for the two-year study of habitat, distribution, and population structure of juvenile white sturgeon, *Acipenser transmontanus*, in the Lower Fraser River. Under the project, data gathering was funded for 1992 and 1993; however, this report will also include data collected by the Malaspina University-College Fisheries and Aquaculture Department in 1985, 1986, and 1987. The study includes a compilation and analysis of baseline data on juvenile sturgeon, gathered largely in sloughs and backwaters of the river downstream of Hope, B.C.

On April 11, 1990, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) approved the status of "vulnerable" for white sturgeon in unique in British Columbia and, for that matter, in Canada, as it is the largest freshwater fish, with unsubstantiated records to 910 kg and substantiated records to 630 kg (Scott and Crossman, 1973). We have aged a much smaller fish at 82 years (it was 320 cm in length, with an approximate weight between 200 kg and 300 kg, based on the length/weight curve), so these very large fish may been well over 100 years old. The acipenserids are more primitive than the modern bony fishes (teleosts), and sturgeon likely represent the oldest evolved freshwater jawed fish in British Columbia (lampreys maybe older but they do not have jaws). In Canada, white sturgeon are known to be native to two river systems: the Fraser and the Columbia (Figure 1). At present, only one spawning site in Canada has been located on the Columbia system (R.L. and L. Environmental Services, 1994), and none have been located on the Fraser, although spawning must occur in the Fraser as there is annual recruitment of juveniles.

There have been two notable works on aspects of the white sturgeon populations in the Fraser River. Semakula and Larkin (1968) reported on sturgeon from the Lower Fraser River, and Dixon (1986) looked in sturgeon populations in the Upper Fraser and Nechako Rivers.

(28) Lord, J. K. 1866. The naturalist in Vancouver Island and British Columbia. Richard Bentley, London, England, 175-186 p.

SUMMARY: An expert from "The naturalist in Vancouver Island and British Columbia" describing how sturgeon-spearing fishing is accomplished by natives on the Fraser and Columbia rivers. The distribution and description of the white sturgeon, *Acipenser transmontanus*, is also discussed in this paper.

(29) MacDonald, A. L. 1987. The Indian food fishery of the Fraser River: 1986 Summary. Can. Data. Rep. Fish. Aquat. Sci. No. 623: 103 p.

ABSTRACT: Weekly efforts levels and catches of five species of Pacific salmon (genus ***Oncorhynchus***), steelhead trout (***Salmo gaurdneri***) and white sturgeon (***Acipenser transmontanus***) are reported for all 23 fishing areas of the Fraser River Indian food fishery in 1986. The annual catch of 605,343 salmon and steelhead was the highest on record. The catch by species was 15,645 chinook salmon (***O. tshawytscha***), 533,859 sockeye salmon (***O. nerka***), 35,143 coho salmon (***O. kisutch***), 16,711 chum salmon (***O. keta***), 3,985 steelhead and 1,794 sturgeon. A standard management plan for the fishery was amended because conservation of early and middle timed chinook and early Stuart sockeye stocks was required. For the first time, in-season management actions were taken to keep sockeye catches within prescribed limits. Hardcopy and electronic files available, please refer to raw data reference 7 in "Raw Data Sources" section.

(30) MacDonald, A. L. 1988. The Indian food fishery of the Fraser River: 1987 Summary. Can. Data. Rep. Fish. Aquat. Sci. No. 690: 113 p.

ABSTRACT: Weekly effort levels and catches, and catch per unit effort of five species of Pacific salmon (***Oncorhynchus spp.***), steelhead trout (***Salmo gairdneri***) and sturgeon (***Acipenser spp.***) are reported for all 23 fishing areas of the Fraser River Indian food fishery in 1987. The annual catch of 605,366 salmon and steelhead was the second highest on record. The catch by species was 14,525 chinook salmon (**O. tshawytscha**), 468,023 sockeye salmon (***O. nerka***), 70,514 pink salmon (***O. gorbuscha***), 23,737 coho salmon (***O. kisutch***), 26,312 chum salmon (***O. keta***), 2,255 steelhead and 1,479 sturgeon. A standard management plan for the fishery was amended because conservation of early and middle timed chinook and early Stuart sockeye stocks was required. For the second consecutive year, in-season management actions were taken to keep sockeye catches within an allocation of 500,000 fish for the entire fishery. Hardcopy and electronic files available, please refer to raw data reference 8 in "Raw Data Sources" section.

(31) MacDonald, A. L. 1989. The Indian food fishery of the Fraser River: 1988 Summary. Can. Data. Rep. Fish. Aquat. Sci. No. 725: 107 p.

ABSTRACT: Weekly effort levels and catches, and catch per unit effort of five species of Pacific salmon (***Oncorhynchus spp.***), steelhead trout (***Salmo gairdneri***) and sturgeon (***Acipenser spp.***) are reported for all 23 fishing areas of the Fraser River Indian food fishery in 1988. The annual catch of 491,804 salmon and steelhead was the sixth highest on record. The catch by species was 15,589 chinook salmon (***O. tshawytscha***), 416,044 sockeye salmon (***O. nerka***), 38,524 coho salmon (***O. kisutch***), 19,143 chum salmon (**O. keta**), 2,504 steelhead (**O. mykiss**) and 6,032 sturgeon. A standard management plan for the fishery was amended because conservation of early and middle timed chinook and early Stuart sockeye stocks was required. For the third consecutive year, in-season management actions were taken in an attempt to

achieve an allocation of 500,000 sockeye for the entire fishery. Hardcopy and electronic files available, please refer to raw data reference 9 in "Raw Data Sources" section.

(32) MacDonald, A. L. 1990. The Indian food fishery of the Fraser River: 1989 Summary. Can. Data. Rep. Fish. Aquat. Sci. No. 787: 111 p.

ABSTRACT: Weekly effort levels and catches, and catch per unit effort of five species of Pacific salmon and steelhead (***Oncorhynchus spp.***) and sturgeon (***Acipenser spp.***) are reported for all 23 fishing areas of the Fraser River Indian food fishery in 1989. The annual catch of 674,023 salmon and steelhead was the highest on record. The catch by species was 5,983 chinook salmon (***O. tshawytscha***), 541,943 sockeye salmon (***O. nerka***), 72,443 pink salmon (***O. gorbuscha***), 10,245 coho salmon (***O. kisutch***), 12,785 chum salmon (***O. keta***), 624 steelhead (***O. mykiss***) and 4,086 sturgeon. A standard management plan was amended because conservation of early and middle run chinook stocks was required. For the fourth consecutive year, in-season management actions were taken to keep sockeye catches within an allocation of 500,000 sockeye for the entire fishery. Hardcopy and electronic files available, please refer to raw data reference 10 in "Raw Data Sources" section.

(33) MacDonald, A. L. 1991. The Indian food fishery of the Fraser River: 1990 Summary. Can. Data. Rep. Fish. Aquat. Sci. No. 836: 105 p.

ABSTRACT: Weekly effort levels and catches, and catch per unit effort of five species of Pacific salmon and steelhead (***Oncorhynchus spp.***) and sturgeon (***Acipenser spp.***) are reported for all 23 fishing areas of the Fraser River Indian food fishery in 1990. The annual catch of 853,489 salmon and steelhead was the highest on record. The catch by species was 17,885 chinook salmon (***O. tshawytscha***), 807,618 sockeye salmon (***O. nerka***), 13,633 coho salmon (***O. kisutch***), 13,833 chum salmon (***O. keta***), 520 steelhead (***O. mykiss***) and 5,815 sturgeon. A standard management plan for the fishery was amended because conservation was required for early, middle, and late run chinook stocks, Early Stuart River sockeye salmon, and Thompson River steelhead. For the first time since 1985, a management plan was implemented without sockeye salmon allocation. Hardcopy and electronic files available, please refer to raw data reference 11 in "Raw Data Sources" section.

(34) MacDonald, A. L. 1992. The Indian food fishery of the Fraser River: 1991 Summary. Can. Data Rep. Fish. Aquat. Sci. No. 876: 86p.

ABSTRACT: Estimates of weekly effort levels and catches of Pacific salmon and steelhead trout (***Oncorhynchus spp.***) and sturgeon (***Acipenser spp.***) were reported by area for the Fraser River Indian food fishery in 1991. The annual catch of 752,050 salmon and steelhead was the second highest on record for the 1951-1991 period. Catch by species in 1991 was 16,869 chinook salmon (***O. tshawytscha***), 605,930 sockeye salmon (***O. nerka***), 103, 782 pink salmon (***O. gorbuscha***), 9,386 coho salmon (***O. kisutch***), 15,799 chum salmon (***O. keta***), 284 steelhead (***O. mykiss***), and 1,459 sturgeon. Management in 1991 was based principally on a fishing plan that developed and became standardized over the last several decades. The plan was modified to take into account conservation concerns for chinook stocks, a 800,00 sockeye allocation comprised of a base allocation of 500,00 fish and a transitional amount of 300,00 fish, and consultative input from Indian bands and organizations. Hardcopy and electronic files available, please refer to raw data reference 12 in "Raw Data Sources" section.

(35) MacDonald, D. D., M. G. Ikononmou, A. Rantalaine, I. H. Rogers, O. Sutherland, and J. Van Oostdam, 1997. Contaminants in white sturgeon from the upper Fraser River, British Columbia, Canada. Environ. Toxicol. Chem. 16(3), 479-490.

ABSTRACT: Four white sturgeon were collected from the upper Fraser River near Prince George, British Columbia, Canada, in the fall of 1991 and 1992. Two additional fish were taken from the Fraser River near Williams Lake, some 250 km downstream of Prince George. Samples of white muscle, red muscle, liver, and roe were analyzed for metals, polychlorinated dibenzo-*p*-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), non-ortho and mono-ortho polychlorinated biphenyls (PCBs), and chlorophenols to determine whether the tissues of this species were acceptable for human consumption. The concentrations of mercury in the white muscle and lover of several fish from the upper Fraser River exceeded the provincial tissue residue criteria for people who consumed low quantities fo fish (i.e., 210 g wet weight/week). The concentrations of PCDDs, PCDFs, and coplanar PCBs (expressed as 2, 3, 7, 8-tetrachlorodibenzo –p- dioxin toxic equivalents) in red muscle and liver of these fish exceeded the Health Canada working guidelines for the protection of human health. By comparison, white sturgeon in the lower Fraser had much lower concentrations of metals and organic contaminants. The differences in contaminant burdens in fish from the two widely separated reaches of the river reflect their proximity to or distance from known contaminant sources.

(36) Margolis, L. and T. E. McDonald. 1986. Parasites of white sturgeon, *Acipenser transmontanus*, from the Fraser River, British Columbia. J. Parasit. 72(5), 794-796.

SUMMARY: The purpose of this report is to summarize the data on parasites of 36 white sturgeon collected from the Nicomen Slough, lower Fraser River, British Columbia, in 1983. This report represents the first on parasites of the Fraser River stock of white sturgeon, which is one of the major stocks of this North American sturgeon species

(37) McAdam, S. 1995. Report on the mortalities of Fraser River white sturgeon (*Acipenser transmontanus*) during the summer-fall period of 1993-94. Draft Regional Fisheries Report. 12 p.

SUMMARY: This report addresses mortalities of white sturgeon (*Acipenser transmontanus*) which were particularly notable in the Lower Fraser River during the summer/fall period of 1993 and 1994. The cause of the mortalities is unknown, and investigation of this problem is ongoing. This report summarizes the information to date and discusses possible explanations for sturgeon mortalities.
This report addresses mortalities of white sturgeon (*Acipenser transmontanus*) which were particularly notable in the Lower Fraser River during the summer/fall period of 1993 and 1994. The cause of the mortalities is unknown, and investigation of this problem is ongoing. This report summarizes the information to date and discusses possible explanations for sturgeon mortalities.

(38) McDonald, T. E., V. J. Swiatkiewicz, E. D. Lane, F. Dalziel, and L. Margolis. 1987. Release and recovery data for tagged Fraser River white sturgeon, (*Acipenser transmontanus*), in 1985. Can. Data. Rep. Fish. Aquat. Sci. No. 639: 27 p.

ABSTRACT: This report provides length, weight, and release data on 712 white sturgeon, *Acipenser transmontanus Richardson*, caught and tagged at several localities in the lower Fraser River from May to September, 1985. Data for 13 fish recovered in 1985 are also included.

(39) McDonald, T. E., V. J. Swiatkiewicz, E. D. Lane, F. Dalziel, and L. Margolis. 1989. Recoveries in 1985 and 1986 and releases of tagged Fraser River white sturgeon, *Acipenser Transmontanus*, together with data on the number of dorsal scutes and number of *Cystoopsis Acipenseris* (Nematoda) present on some of the fish caught in 1986. Can. Data. Rep. Fish. Aquat. Sci. No. 742: 33 p.

ABSTRACT: This report provides length, weight, and release data on 507 white sturgeon, *Acipenser transmontanus Richardson*, caught and tagged at several localities in the lower Fraser River from April to November 1986, as well as recovery data for 73 tagged fish. Eight of these tagged fish were recovered in 1985 and 65 fish were recovered in 1986. Data on the number of dorsal scutes present on each fish tagged by the Province of British Columbia as well as data on the occurrence of the nematode Cystoopsis acipenseris Wagner, 1867 in sturgeon caught at Nicomen Slough are also presented. Nine fish had radio tags attached externally on the dorsal surface, and four of them were also tagged with Petersen disc tags.

(40) Nelson, T. C. 1997. Bowron River white sturgeon inventory 1995-1996. Report prepared for B.C. Ministry of Environment, Lands and Parks, Fish and wildlife Branch, Prince George, B.C., by LGL Limited., Sidney, BC. 38 p.

SUMMARY: This report presents the results of a reconnaissance-level inventory of white sturgeon (*Acipenser transmontanus*) in the Bowron River, a major tributary to the upper Fraser River northeast of Prince George.

(41) Nelson, J., C. Smith, E. Rubidge, and B. Koop. 1999. Genetic analysis of D-Loop region and microsatellite DNA of white sturgeon from British Columbia-population structure and genetic diversity. Unpublished report prepared for BC Fisheries, Conservation Section, Victoria, BC.

SUMMARY: White sturgeon, *Acipenser transmontanus*, range from southern Alaska to northern California. These large, primarily freshwater fish mature between 11 and 34 years and can live to be over 70 years old. These fish are found throughout the Fraser River and have been historically an important sporting and food source for residents of British Columbia. The Ministry of Fisheries is interested in information regarding the life history and population substructure for these fish. As part of these efforts, analysis of mitochondrial and nuclear DNA has been undertaken. The work described in this report follows initial work undertaken by Drs. Sheldon Mckay and Ben Koop. Dr. Mckay isolated microsatellite loci from *A. transmontanus* and performed sequence analysis of the D-Loop region of *A. transmontanus* mitochrondrial DNA.

This report is presented in two parts. Section 1 includes the results of the mitochrondrial DNA analysis and well as the supporting technical information to fulfilling the requirements of Ministry of Fisheries contract 690-06090 HCP02 to Seastar Biotech. This section also includes a description of the development of the RFLP method. Section 2 includes the results of microsatelitte DNA assays performed by Christian Smith (University of Victoria). After presentation of the results and interpretation based on both types of markers we attempt to synthesize a coherent picture of what these markers are suggesting regarding the population sub structuring of white sturgeon.

(42) Northcote, T. G. 1974. Biology of the lower Fraser River: a review. Westwater Research Centre. University of British Columbia Technical Report No. 3: 78 p.

SUMMARY: One of the objectives of the Westwater Research Centre's study on the lower Fraser River is "to provide a good basis for estimating the specific physical and biological effects of factors which influence {its} water quality...." (Westwater Notes, No. 2, August 1972). As part of this study, a program has been developed to gather information on major biological communities in the mainstem river between Hope and its mouth. In doing so, it seemed essential to review and summarize relevant biological data currently available in the published literature, in reports of the several agencies responsible for management of some species of the river biota, in theses and other studies conducted at universities, and from the experience of those familiar with special aspects of the river biology. It would have been desirable and most certainly in vogue to have undertaken an "ecological review" of the lower mainstem Fraser. However, for a system with so little known about some major components of its biota, such an approach seemed premature if not presumptuous so a review with more limited scope was attempted.

Undoubtedly studies will have been missed, others inadequately represented, and possibly some misinterpreted. If this review brings to light a little known work on the river, if it reveals aspects of the river's biology poorly understood or indicates gaps critical to management of its resources, it will have served a useful purpose. Hopefully, the review may stand as a convenient summary available to all those concerned with biological conditions, water quality, and resource utilization in the lower portion of this major Canadian river.

(43) Northcote, T. G., N. T. Johnston, and K. Tsumura. 1975. Trace metal concentrations in lower Fraser River fishes. Westwater Research Centre, University of British Columbia, Tehnical Report No. 7: 41 p.

SUMMARY: Concentrations (ppm, wet weight) of mercury, silver, copper, zinc, nickel, lead, cadmium, iron, manganese, cobalt, and molybdenum were determined in the expaxial white muscle tissue of 348 specimens of 14 species of fish taken from the Fraser River downstream of Hope, British Columbia. Silver, nickel, cobalt, and molybdenum were not detected in any fish. Lead was only found in three white sturgeon (0.56-0.94 ppm) and one peamouth chub (0.33 ppm) from lower reaches of the river. Cadmium appeared in only one fish (0.38 ppm), a white sturgeon from the same area. On the other hand, mercury, copper, zinc, iron and manganese were found in detectable concentrations in virtually all fish sampled. Copper concentrations in the fish samples averaged below 0.75 ppm (maximum 1.53 ppm) and manganese below 0.51 ppm (maximum 1.81 ppm), while iron levels were about ten times higher, presumably related to normal metabolic requirements. No obvious differences in concentrations of copper, manganese or iron were noted for the fish species tested, in contrast to marked inter-specific differences in concentrations of mercury and zinc.

Salmonoids (salmon, trout, char, whitefish) had very low muscle tissue concentrations of mercury (average less than 0.15 ppm; maximum 0.31 ppm), all considerably below the Canadian Food and Drug Directorate standard for human consumption (0.5 ppm). Low mercury levels in these species may be attributed in part to the fact that many are anadromous forms not resident in the river. The northern squawfish and prickly sculpin, fishes of high trophic status resident in the river, contained the highest levels of mercury with averages above 0.65 ppm (maximum 1.99 ppm). Other species showed intermediate mercury concentrations. Zinc levels were highest in northern squawfish, peamouth chub and prickly sculpin (maximum 21.01 ppm) but in all cases very much less than the Canadian standard for human consumption (100 ppm). No significant

differences in average trace metal concentrations in fish were found between major regions of the lower Fraser River, although fish movements could obscure sources for trace metal accumulation. In particular, fishes from the lowermost heavily urbanized and industrialized reaches of the river did not show elevated trace metal concentrations compared with those from the upper more agricultural reaches.

Concentrations of mercury and zinc were dependent on the size of the fish, mercury increasing and zinc decreasing in larger fish. Concentrations of other metals were apparently independent of fish size. In general there was no correlation between concentrations of different trace metals within individual fish; a high level of one metal did not necessarily imply a high level of any other. Trace metal concentrations found in Fraser River fishers are generally quite low, both in comparison to values from other systems in British Columbia, in North America or in Europe, and with respect to standards for human consumption of fish. The sole exception is mercury, particularly in northern squawfish and prickly sculpins. That mercury levels should be highest in these resident species of high trophic status suggests that mercury loadings to the river may not be insignificant and that further studies on sources and pathways of accumulation within the river ecosystem are needed.

(44) Palermo, V. and A. S. Thompson. 1999a. Angler effort and catch in the 1997 lower Fraser River sport fishery. Can. Manuscr. Rep. Fish. Aquat. Sci. No. 2488: 24 p.

ABSTRACT: The lower Fraser River main stem recreational fishery was assessed from 1985 to 1988 and again in 1995 and 1996, using a combined access point/over flight survey design. From July 1 to August 31, 1997, another recreational fishery survey was conducted on the lower Fraser River using the same study design and the data entry and analysis program that was implemented during the 1996 survey. The 1997 survey focused on angler effort and the harvest and release of chinook (*Oncorhynchus tshawytscha*), sockeye (*O. nerka*) and pink (*O. gorbuscha*) salmon.

Over the course of the survey, 17 over flights and 5,275 angler interviews were conducted. Angler effort was estimated at 260,874 hours. Total harvests of chinook (adults and jacks combined) and sockeye were estimated at 1,687 and 30,458, respectively. Chinook and sockeye released were estimated at 184 and 20,764, respectively. Pink salmon constituted less than 1% of the total season sport catch.

The 1997 July chinook catch was significantly less than the 1996 catch, due to a decreased proportion of effort directed at chinook and low abundance of chinook in the river. Chinook abundance increased substantially during August, but they were not targeted and catch remains low. Catch rates for sockeye increased dramatically from 1996 to 199, particularly during July, due to an increased proportion of angler effort directed at sockeye and high sockeye abundance. August angler effort was moderately higher than in 1996. Estimated sturgeon releases for Regions 3 and 4 of the lower Fraser River totaled 242 in July and 329 in August.

(45) Palermo, V. and A. S. Thompson. 1999b. Angler effort and catch in the 1998 lower Fraser River sport fishery. Can. Manuscr. Rep. Fish. Aquat. Sci. No. 2484: 31 p.

ABSTRACT: The lower Fraser River mainstem recreational fishery was assessed from 1985 and 1988 and from 1995 to 1997, using an access point/overflight survey design. From May 1 to August 31, 1998, another recreational fishery survey was conducted on the lower Fraser River using the same study design and the data entry and analysis program that was implemented

during the 1996 survey. The 1998 survey focused on angler effort and the harvest and release of chinook (*Oncorhynchus tshawytscha*) and sockeye (*O. nerka*) salmon.

Over the course of the survey, 31 over flights and 6,704 angler interviews were conducted. Angler effort was estimated at 360, 449 hours. Total harvest of chinook (adults and jacks combined) and sockeye were estimated at 7,181 and 9,655, respectively. Chinook and sockeye released were estimated at 264 and 6,219 (minimum estimate), respectively.

The 1998 July and August chinook catch increased substantially from 1997, due to a higher proportion of effort directed at chinook and increased chinook abundance in the river. Catch rates for sockeye decreased dramatically from 1997 to 1998, due to their decreased abundance in the river and a decreased proportion of angler effort directed at sockeye. July angler effort was higher than in 1997, but August effort was down, probably as a result of closures in the sockeye fishery. Estimated sturgeon releases for Regions 3 and 4 of the lower Fraser River totaled 19 in May, 101 in June, 399 in July, 631 in August, for a total of 1,150. Mean monthly RPUE (release per unit effort) and CPUE (catch per unit effort) are also presented for Fraser River white sturgeon Region 3 and 4 sport fisheries.

(46) Palermo, V. and A. S. Thompson. 2000. Angler effort and catch in the 1998 sport fisheries of five lower Fraser River tributaries. Can. Manuscr. Rep. Fish. Aquat. Sci. No. 2530: 55 p.

ABSTRACT: The lower Harrison River recreational fishery was assessed from September 1 to November 30, 1998, suing an access point and over flight survey design. The Chehalis River and the Nicomen Slough and Norrish Creek sport fisheries were assessed from September 1 to December 14, 1998, using combined roving and instantaneous effort count study designs. The lower Stave River was assessed from September 1 to December 14, 1998, using an access point, roving and instantaneous effort count survey design. Finally, the Vedder-Chilliwack River sport fishery was assessed from September 1 to November 30, 1998, using a roving and over flight survey design. The studies focused on angler effort and the harvest and release of coho (*Oncorhynchus kisutch*), chum (*O.keta*), sockeye (*O. nerka*) and chinook (*O. tshawytscha*) salmon.

Over the course of the five studies, a total of 19,808 angler interviews and 106 instantaneous effort counts were conducted. Total angler effort was estimated at 423, 369 hours. Total harvests of coho and chum salmon were estimated at 11,075 and 6,329; harvests of sockeye and chinook salmon were estimated at 1,733 and 12,852. Total releases of coho and chum salmon were estimated at 13,992 and 37,796; releases of sockeye and chinook salmon were estimated at 2,559 and 19,703. Total harvest and release information for white sturgeon at Harrison River, Nicomen Slough, and Norrish Creek is presented by month.

(47) Parks, N. B. 1978. The Pacific northwest commercial fishery for sturgeon. Mar. Fish. Rev. 40(7): 17-20.

SUMMARY: The purpose of this report summarizes the Pacific Northwest commercial fishery for green and white sturgeon. The paper discusses the history of the sturgeon commercial fishery on the Fraser River and the Columbia River, the description of the fishery, and the current trend and future status of the sturgeon stocks.

(48) Perrin, C. J., Heaton, A., and M. A. Laynes. 1999. White sturgeon (*Acipenser transmontanus*) spawning habitat in the lower Fraser River, 1998. Report prepared by Limnotek Research and Development Inc. for B.C. Ministry of Fisheries, Victoria, B.C. 53p.

SUMMARY: Spawning habitat used by White Sturgeon (Acipenser transmontanus) in the Fraser River between Mission and Yale was described from field observations compiled in summer, 1998. Location of sturgeon that were radio tagged in 1997 was determined by boat radio tracking over the complete study area from Mission to Yale on 7 dates between June 19 and October 27, 1998. Locations where potential spawners were repeatedly detected were identified as priority sites for sampling of sturgeon embryos and larvae. These collections were used to indicate the approximate location and time of spawning. Artificial substratum mats and D-ring nets were used for these collections over a sampling period of June 19 through July 23, 1998. Beach seining was also completed on July 20 and Aug 11.

Sixteen species of fish common to the Fraser River were captured using the substratum mats, D-ring nets, and beach seine. A total of 20 white sturgeon larvae and 2 embryos were collected from side channels near areas locally known as the Herrling channel (river km 120-130) and Minto channel (river km 101-106), both located downstream of Hope. spawning may be been lower. The maximum temperature is defined as the mean temperature measured on the latest date when spawning occurred on the basis of calculations from captured embryos and larvae.

Insight into the distribution and characteristics of spawning habitat has greatly improved with completion of this study; however, descriptions were based on low numbers of embryos and larvae. Definitive evidence of spawning location is still lacking. To improve precision of data describing spawning habitat, it is recommended that surveys continue in 1999. A hypothesis was developed in this study that light attenuation caused by high concentrations of suspended particles may be important factor determining location and particularly water depth at spawning sites in side channels downstream of Hope. It is recommended that further data be collected in 1999 to investigate this relationship further. Hardcopy and electronic files available, please refer to raw data reference 22 in "Raw Data Sources" section.

(49) Perrin, C. J. 2000. The impact of suction dredging on the abundance of white sturgeon (*Acipenser transmontanus*) and its food resources in the Fraser River at Mission. Report prepared for Mission Valley Shopping Centre Ltd., Vancouver, BC by Limnotek Research and Development Inc., and Cascade Fishing Charters Ltd. 69 p.

SUMMARY: As part of an agreement between the Province of British Columbia and Mission Valley Shopping Centre Ltd. the effects of suction dredging on abundance of white sturgeon and their food resources was examined in the Fraser River at Mission in 1997 through 1998. The impact assessment involved a weight-of-evidence approach to examine the role of dredging in contributing to observed variation in sturgeon abundance and the abundance and composition of food supplies between control and dredged sites over time. Conventional inferential statistics could not be applied because of the lack of treatment replication.

Suction dredging between January 20, 1998 and February 19, 1998 removed 477, 000 m^3 of sand from a 10 ha area in the north channel of the Fraser River at Matsqui Island. The sand was pumped to Mission and used as a preload and fill to achieve a minimum grade elevation for construction of the Mission Valley Shopping Centre. Sturgeon in a control area and at the

dredged location were caught by angling and set lines on one sampling series before dredging (December 1997) and on two series after dredging (March 1998 and September 1998). All captured sturgeon were tagged and released. Potential sturgeon food organisms and other benthic organisms were sampled in benthic grabs on the same dates when sturgeon were collected an in December 1998 to examine potential recovery from disturbance up to 10 months after dredging. Crayfish traps were also used to provide data on large benthic organisms that were not catchable in benthic grabs.

A total of 68 sturgeon were caught on all sites and dates. There were no recaptures, which prevented a population estimate from being determined. There were no large differences in catch rates between control and borrow sites at points in time. Seasonal variation appeared to be greater factor in determining catchability of sturgeon with greater catch rates occurring in summer (81 % of all captures occurred in series 3) than in winter (9% in series 1 and 10% in series 2). Analysis of stomach contents that were collected in the September catch revealed that sturgeon were feeding on organisms that could be found outside the study area. This finding in combination with the absence of recaptures and no large differences in catch rates between sites suggested that captured sturgeon were moving through rather than holding and actively feeding in the study area. This finding suggested that sturgeon abundance in the control and dredged locations was determined by external movement patterns unrelated to demands on habitat within the study area. Radio tracking of captured sturgeon before and after dredging event would be required to confirm movements and test this hypothesis. Hardcopy and electronic files available, please refer to raw data reference 23 in "Raw Data Sources" section.

(50) Perrin, C. J. and E. A. Shaw. 2000. The effect of transfer pit operations on fish, benthic invertebrates and habitat in the Fraser River at Barnston Island, 2000. Preliminary Data Report. Report prepared for Fraser Estuary Management Program, Burnaby, BC, by Limnotek Research and Development Inc. 43 p.

SUMMARY: This study involved measurement of several biological endpoints and habitat parameters in a control and treatment area before and after dredging and backfilling a sand transfer pit in the Fraser River at Barnston Island. The transfer pit area measured 300 m x 120 m and dredging was permitted over a substratum depth of 3 m for a total sand volume of 108,000 m^3. Due to a late start of dredging on March 6, 2000, only 72,000 m^3 of sand was dredged and pumped to shore. Equipment was not permitted to operate past March 15 because of risk of intercepting and entraining eulachon that migrate upstream for spawning at that time. Pre-dredging sampling of all parameters occurred over three days beginning on January 25, 2000. Dredging and backfilling of the pit occurred on March 6-15, 2000, during which time measurements of turbidity were collected upstream and downstream of the operating dredge. Post-dredging sampling of all parameters was completed on March 22-24, 2000. This report is a compilation of resulting data from these initial sampling dates. It is anticipated that replicate sampling will be completed at later dates to examine recovery over time.

Fish were collected with the use of minnow traps, angling, crayfish traps, set lines, trawl, gill net sets, and a plankton net designed for capture of downstream migrating fish. A total of 40 fish were caught using all gear types across all date and location combinations. Before dredging, no fish were caught in the control area while two prickly sculpin, one starry flounder, and one white sturgeon were caught at the dredge location. Sampling after dredging in March 2000 yielded larger numbers of prickly sculpin, sturgeon, and salmon juveniles. One coast range sculpin was also caught at that time. Prickly sculpin was most commonly found in fishing gear (19 fish caught) and it was caught at highest rates of only 0.0009-0.006 fish/trap/hr using minnow traps

and crayfish traps. A total of 4 white sturgeon were caught at capture rates of 0.05fish/hook hr by angling, 0.001 fish/hook suing set lines, and 0.5 fish/net hr using gill nets. The sturgeon capture rate by angling was similar to that recorded upstream at Mission in an earlier study and the capture rate using set lines was greater than that found at Mission. The larger numbers of fish caught in March compared to January at both sites implied greater presence of fish in the early spring regardless of dredging. Numbers of any given fish species, however, were very low during both sampling series, preventing statistical analysis of a location effect between dates. No fish were recaptured between dates, preventing determination of population size of any species. Sizes of sturgeon were small compared to those captured in an earlier study at Mission. Lengths at Barnston Island were 37.5-121.5 cm and mean length was 73.1 cm. Mean sturgeon length at Mission in winter was 123.6 cm. All sturgeon were successfully tagged with floy tags and pit tags before release.

Hardcopy and electronic files available, please refer to raw data reference 24 in "Raw Data Sources" section.

(51) Perrin, C. J., Heaton, A., and M. A. Laynes. 2000a. White sturgeon (*Acipenser transmontanus*) spawning habitat in the lower Fraser River, 1999. Report prepared by Limnotek Research and Development Inc. for BC Ministry of Fisheries, Victoria, BC. 53p.

SUMMARY: A description of spawning habitat used by white sturgeon (*Acipenser transmontanus*) in the lower Fraser River between Mission and Yale was compiled from field observations completed in spring and summer, 1999. This work provided an updated understanding of characteristics of spawning habitat that was initially described from observations in 1998. Location of white sturgeon, potentially in spawning condition and were radio-tagged in 1997, was determined by boat radio tracking over the complete study area from Mission to Yale on 6 dates between June 20 and August 29, 1999. Opportunistic radio tracking during travel between sampling sites was completed on 12 other dates. Locations where potential spawners were repeatedly detected were identified as priority sites for sampling of white sturgeon eggs, embryos, and larvae. These collections were used to indicate the approximate location and time of spawning.

Twelve species of fish common to the Fraser River were captured using substratum mats and D-ring nets. A total of 81 white sturgeon larvae, 78 embryos, and 3 unfertilized eggs were collected from main channel and side channel habitat upstream and downstream of Hope. Back calculated dates determined from date of capture and known age of captured embryos, eggs, and larvae showed that spawning occurred between June 18 and August 8 in 1999. Location of spawning was indirectly found in wide ranging main channel and side channel habitat.

This study confirms findings from 1998 that spawning can occur mainly in side channel habitat downstream of Hope and mainstem habitat upstream of Hope. Sampling methods, however, did not preclude the possibility of spawning occurring in the main channel downstream of Hope. Characteristics of spawning habitat in the lower Fraser River differed from those described in other white sturgeon rivers in three respects. Spawning habitat in the Fraser River had shallower water depths, much higher turbidity, and smaller substrata particle sizes compared to the other systems.

Hardcopy and electronic files available, please refer to raw data reference 25 in "Raw Data Sources" section.

(52) R. L. & L. Environmental Services Ltd. 1996. Fraser River white sturgeon monitoring program. 1995 data report. Report prepared for BC Ministry of Environment, Lands and Parks, Fisheries Branch. R.L. &L. Report No. 465F: 6 p. + 5 app.

SUMMARY: Set lines and angling were used to capture and study white sturgeon in selected reaches of the Fraser River watershed in BC Environment Regions 2 (Lower Mainland), 3 (Thompson-Nicola), 5 (Cariboo), and 7 (Omineca-Peace). Within Region 2, white sturgeon were documented from Mission to Yale and were associated with either the confluences of major tributaries, backwaters and sloughs, or deep areas in the mainstem. Sturgeon sampled in Region 3 were collected from Lytton to Lillooet and were primarily recorded in backwater habitats characterized by low water velocities and increased water depth. In Region 7, localized concentrations of white sturgeon were identified in three areas: immediately downstream of Vanderhoof, at the Sinkut River confluence area, and in the Finmore area. Typically individuals were associated with deeper sections of the mainstem that exhibited depths ranging from 4 to 10 m. Movements of white sturgeon were monitored using mark-recapture and radio telemetry techniques. Limited information on movement patterns of white sturgeon were documented in 1995. Captured white sturgeon ranged in fork length from 42.5 to 215.5 cm and the largest individual weighed 90.9 kg. Hardcopy and electronic files available, please refer to raw data reference 27 in "Raw Data Sources" section.

(53) R. L. & L. Environmental Services Ltd. 1997a. Fraser River white sturgeon monitoring program. Region 2 (Lower Mainland) – 1996 Investigations. Report prepared for BC Ministry of Environment, Lands and Parks, Fish and Wildlife Section, Surrey, BC. R.L. &L. Report No. 524F: 6 p. + 5 app.

SUMMARY: A total of 413 white sturgeon were captured during the 1996 study period. Of these, 356 received Floy tags and 345 received PIT tags. Twenty fish were recaptured during the 1996 study period; four were originally released in 1995 and 16 were released in 1996. The majority of the marked and recaptured white sturgeon population were recaptured within 3 km of their original capture location. Hardcopy and electronic files available, please refer to raw data reference 27 in "Raw Data Sources" section.

(54) R. L. & L. Environmental Services Ltd. 1997b. Fraser River white sturgeon monitoring program. Region 3 (Thompson-Nicola) – 1996 Investigations. Report prepared for BC Ministry of Environment, Lands and Parks, Fish and Wildlife Section, Kamloops, BC. R.L. &L. Report No. 536F: 37 p. + 5 app.

SUMMARY: This report summarizes results from the second year of the Fraser White Sturgeon Monitoring Program in the middle Fraser River (i.e. Region 3: Thompson-Nicola) and provides comparisons with data obtained from the initial phase of the program in 1995.

Angling and set lines were the two methods used to capture white sturgeon in the Region 3 sample area.

In 1996, surveys were conducted in the mainstem Fraser River from Boston Bar (Km 225) to Bridge River rapids (Km 331). Areas used by white sturgeon documented for the summer to fall and winter periods were identified in the Fraser River. White sturgeon were typically found in

large backwater habitats characterized by reduced water velocities and increased depths compared with mid-channel, mainstem conditions.

Fraser River sturgeon movements were monitored using mark-recapture (i.e. conventional tags) and radio-telemetry programs. Since few fish have been recaptured to date, descriptions of movements primarily represent results of the radio telemetry program conducted in the fall and winter 1996.

The fork length of white sturgeon captured since 1995 ranged from 58.0 to 268.5 cm; the largest individual weighed 150.9 kg. An estimate of the growth rate of white sturgeon sampled in the Region 3 sample area was within the range of predicted length-at-age data presented in the literature for sturgeon populations previously investigated in the Fraser River basin.

Surgical assessments of sexual maturity were conducted on sturgeon collected in the Region 3 sample area.

Information on habitat conditions in the study area and the general characteristics of the habitat at white sturgeon capture locations was obtained during the program. Recommendations for future studies on Fraser River sturgeon are outlined. Hardcopy and electronic files available, please refer to raw data reference 27 in "Raw Data Sources" section.

(55) R. L. & L. Environmental Services Ltd. 1997c. Fraser River white sturgeon monitoring program. Region 7 (Omineca-Peace) – 1996 Investigations. Report prepared for BC Ministry of Environment, Lands and Parks, Fish and Wildlife Section, Prince George, BC. R.L. &L. Report No. 520F: 78 p.

SUMMARY: Set lines and angling were the primary capture methods used during the study, although tangle nets, and boat electrofishing also were used to sample a broader size-range of fish. In 1996, surveys were conducted in the Nechako, Stuart, and Tachie rivers as well as sections of the Nautley River and Fraser Lake. White sturgeon were recorded only in the Nechako and Stuart rivers and exhibited a sporadic distribution with localized concentrations in these systems. In the Nechako River, white sturgeon were recorded from downstream of the Nautley River confluence to upstream of Isle Pierre. Areas classed as high-use were restricted to localized sections of river situated near the confluence of the Nechako and Sinkut rivers and immediately downstream of Vanderhoof. Low to moderate-use areas were documented from upstream of Isle Pierre Rapids to the Sinkut River confluence area, upstream of Sinkut Ranch to upstream of Leduc Creek, and upstream of Neuco Creek to upstream of Vanderhoof. A small number of individuals were sampled in the Stuart River at "Sturgeon Point" and in the Nechako River upstream of Engen. Remaining sections of the Nechako River were classified as undetermined-use areas. Typically, white sturgeon in all areas occupied deeper sections of the mainstem between 4 and 10 m. White sturgeon movements were monitored using mark-recapture and radio-telemetry techniques. The 1995 and 1996 results indicated the majority of the tagged sturgeon resided in localized areas for lengthy periods. Most fish exhiobited sporadic, localized movements of less than 10 km between or within feeding areas. White sturgeon ranged in fork length from 69.0 to 230.5 cm; the largest individual weighed 100.9 kg. Hardcopy and electronic files available, please refer to raw data reference 27 in "Raw Data Sources" section.

(56) R. L. & L. Environmental Services Ltd. 1998a. Fraser River white sturgeon monitoring program. Region 2 (Lower Mainland), 1997 Data Report. Report prepared for BC Ministry of Environment, Lands and Parks, Fish and Wildlife Section, Surrey, BC. R.L. &L. Report No. 564F: 27 p. + 5 app.

SUMMARY: Based on results of the 1995 and 1996 studies that identified requirements for additional information, and the present RED-listed status of the Fraser and Nechako rivers white sturgeon, MELP commissioned further studies in 1997 to continue assessments of the status of the white sturgeon in the Fraser River. This report represents the findings of the third year of the Fraser River White Sturgeon Monitoring Program in Region 2.

In 1997, water temperatures and discharge were recorded continuously. Peak water temperatures in 1997 was 18.2°C; temperatures were similar in 1995 and 1996 and cooler in 1993 and 1994. The 1997 peak discharge was unusually high due to a large snow-pack and rainy spring.

Sampling for egg and larval white sturgeon was conducted to determine the suitability of sample methods for use on the Fraser River.

Angling was conducted between Mission and Siwash Creek. White sturgeon were captured throughout the study area by the study team and charter fishing guides involved with the cooperative angling component of the 1997 program. The study team captured 235 fish and guides contributed an additional 48 fish, for a total catch of 283 white sturgeon. Approximately 17% of the catch were recaptures. The mark-recapture data from 1995 to 1997 were analyzed to provide population estimate of 3470 white sturgeon in the study area.

Life history information was collected from fish captured during the 1997 program. There were more juveniles captured than sub-adults or adult fish, despite the sampling program being biased towards the capture of adult white sturgeon. Hardcopy and electronic files available, please refer to raw data reference 27 in "Raw Data Sources" section.

(57) R. L. & L. Environmental Services Ltd. 1998b. Fraser River white sturgeon monitoring program. Region 3 (Thompson-Nicola)-1997 Data Report. Draft Report prepared for BC Ministry of Environment, Lands and Parks, Fish and Wildlife Section, Kamloops, BC. R.L. &L. Report No. 563F: 30 p. + 6 app.

SUMMARY: The objectives of the 1997 study incorporate elements and recommendations from previous studies and discussions with representatives of BC MELP. The 1997 program was designed to obtain additional information on life history, distribution, behavior, and reproductive status of the white sturgeon population in the middle Fraser River. This report presents findings from the third year (1997) of studies in Region 3 (Thompson-Nicola).

In 1997, set line and angling capture methods were employed in an area that covered the middle Fraser River from below Bridge River Rapids to below Boston Bar, and portions of Seton Lake. Although white sturgeon were not encountered in Seton Lake, they exhibited a widespread occurrence in the Fraser River mainstem above Lytton and a more sporadic distribution between Lytton and Boston Bar.

The movements of the white sturgeon were monitored using both mark-recapture (conventional tagging) and radio telemetry. A total of thirty white sturgeon have been equipped with an

external radio transmitters since 1996. Approximately 77% (n=23) of the radio tagged fish were located in the study area during the 1997 tracking program.

Life history information collected in 1997 suggested the catch was comprised primarily of young, immature or early reproductive fish. The population size of white sturgeon in the study area was estimated at approximately 1740 fish.

Surgical examinations to assess state of reproductive maturity indicated that the population was comprised of mostly younger fish in the earlier stages of reproductive development.

Movement and capture data suggested study area habitats were utilized by white sturgeon primarily for feeding and over wintering. Detailed assessments of habitat were not made during the present study. Hardcopy and electronic files available, please refer to raw data reference 27 in "Raw Data Sources" section.

(58) R. L. & L. Environmental Services Ltd. 1998c. Fraser River white sturgeon monitoring program. Region 5 (Cariboo-Chilcotin)-1997 Data Report. Draft Report prepared for BC Ministry of Environment, Lands and Parks, Fish and Wildlife Section, Williams Lake, BC. R.L. &L. Report No. 589F: 32 p. + 6 app.

SUMMARY: The objectives of the 1997 study incorporate elements and recommendations from previous studies and discussions with representatives of BC MELP. The 1997 program was designed to obtain additional information on life history, distribution, behavior, and reproductive status of the white sturgeon population in the middle Fraser River. This report presents findings from the second year of studies in Region 5 (Cariboo-Chilcotin) in 1997.

In 1997, set line and angling capture methods were employed in an area that covered the Fraser River from the Leon Creek confluence upstream of Quesnel. White sturgeon exhibited a sporadic distribution and primarily inhabited localized areas of eddy and low velocity habitat.

The movement of white sturgeon were monitored using both mark-recapture (conventional tagging) and radio telemetry. Of the nine white sturgeon equipped with radio transmitters in 1997, the majority of the fish exhibited little movement. A few individuals, however, moved larger distances which was characteristic of a fall movement to an over wintering area.

Life history information collected in 1997 suggested the catch was comprised primarily of young, immature or early reproductive fish. The population size of white sturgeon in the study area could not be determined based on the low number of fish captured to date.

A portion of the white sturgeon catch was examined to determine their stage of sexual maturity. These examinations revealed mostly fish in the early stages of reproductive development.

General field observations and capture data suggested areas suitable for feeding, over wintering, rearing, and possibly spawning were available in the study area. Detailed assessments of habitat were not made during the present study. Hardcopy and electronic files available, please refer to raw data reference 27 in "Raw Data Sources" section.

(59) R. L. & L. Environmental Services Ltd. 1998d. Fraser River white sturgeon monitoring program. Region 7 (Omineca-Peace)-1997 Data Report. Draft Report prepared for BC Ministry of Environment, Lands and Parks, Fish and Wildlife Section, Williams Lake, BC. R.L. &L. Report No. 565F: 36 p.

SUMMARY: The 1997 Region 7 study area includes the upper Fraser River from Prince George to above the Bowron River confluence, and portions of the Nechako and Stuart rivers. Information on movements and distribution of white sturgeon were monitored using radio tagging. Hardcopy and electronic files available, please refer to raw data reference 27 in "Raw Data Sources" section.

(60) R. L. & L. Environmental Services Ltd. 1999a. Fraser River white sturgeon monitoring program. Region 2 (Lower Mainland)-1998 Data Report. Report prepared for BC Fisheries, Surrey, BC. and Fraser River Sturgeon Conservation Society. 671F: 22p.

SUMMARY: This report presents the findings of the fourth year of the Fraser River White Sturgeon Monitoring Program in Region 2.

Peak water temperature in the lower Fraser River in 1998 was 21°C, which was warmer than the peak temperature observed in the first three years of the program (1995-1997). The peak discharge was 6710 m^3/s, which was substantially lower than the 1997 and 1996 peak discharge values, but similar to the 1995 peak discharge.

Angling was conducted between Mission and Siwash Creek (upstream of Yale). The overall recapture rate for the 1998 program was 4.3%. The population estimate for the Lower Canyon section was 976 fish (95% CI= 601 to 1598) and for the Lower Mainland section was 17 259 fish (95% CI=6118 to 64 338).

Movements of white sturgeon were monitored using mark-recapture information and radio telemetry. White sturgeon recaptured in 1998 traveled up to 48 km between recapture events, four out of nine recaptured fish moved more than 15 km between captures.

Life history information was collected from fish captured during the 1998 program. The catch consisted of similar numbers of adults (n=80) and sub-adults (n=89) with slightly fewer juveniles (n=62).

Sturgeon use of areas subject to potential dredging activities was preliminarily assessed. Low water levels prevented access to Greyell Channel throughout the study period. A limited amount of sampling was conducted in Minto Channel; three white sturgeon (sub-adults or juveniles) were captured in 12 hook-hours of sampling effort. Hardcopy and electronic files available, please refer to raw data reference 27 in "Raw Data Sources" section.

(61) R. L. & L. Environmental Services Ltd. 1999b. Fraser River white sturgeon monitoring program. Region 3 (Thompson-Nicola)-1998 Data Report. Draft Report prepared for BC Ministry of Environment, Lands and Parks, Fish and Wildlife Section, Kamloops, BC. R.L.&L. Report No. 659F: 29 p. + 5 app.

SUMMARY: The objectives of the 1998 study incorporate elements and recommendations from previous studies and discussions with Mr. I. McGregor and other members of the Fraser River

Sturgeon Technical Committee. The 1998 program was designed to broaden knowledge of sturgeon life history, distribution, behavior, and reproductive status of the white sturgeon in the middle Fraser River.

In 1998, set line and angling capture methods were employed in an area that covered the middle Fraser River from below French Bar Rapids to Saddle Rock. White sturgeon were widely distributed throughout the study area.

Mark-recapture (conventional tagging) and radio telemetry were used to monitor the movements of white sturgeon within the study area. A total of thirty-five white sturgeon have been equipped with an external radio-transmitter since 1996 with four of these fish tagged during 1998.

Analysis of life history information revealed a population comprised mainly of younger cohorts. The population size of the white sturgeon in the study area was estimated at approximately 1778 fish.

Information on sexual maturity form the surgically examined portion of the white sturgeon catch in 1998 indicated that the population was comprised of mostly younger fish in the earlier stages of reproductive development. Hardcopy and electronic files available, please refer to raw data reference 27 in "Raw Data Sources" section.

(62) R. L. & L. Environmental Services Ltd. 1999c. Fraser River white sturgeon monitoring program. Region 5 (Cariboo-Chilcotin)-1998 Data Report. Draft Report prepared for BC Ministry of Environment, Lands and Parks, Fish and Wildlife Section, Williams Lake, BC. R.L.&L. Report No. 656F: 28 p. + 5 app.

SUMMARY: The objectives of the 1998 study incorporate elements and recommendations from previous studies and discussions with Mr. M. Lirette and other members of the Fraser River Sturgeon Technical Committee.

In 1998, set line and angling capture methods were employed in an area that covered the Fraser River from the French Bar Canyon (rKm 409) to Prince George (rKm 785).

Radio telemetry and mark-recapture (conventional tagging) were used to monitor the movements of white sturgeon in the study area. A total of twenty-three radio tags are currently active in the study area; fourteen of these tags were deployed in 1998. Many fish movements occurred within localized areas which suggests a variety of life requisite functions are supported within several higher use areas.

The life history data collected in 1998 indicated the catch was comprised mainly of younger age cohorts. In contrast to previous years, several reproductively mature females were encountered in 1998. Only a portion of the white sturgeon catch was examined to determine their stage of sexual maturity in 1998. These examinations revealed most fish were in the early stages of reproductive maturity. Hardcopy and electronic files available, please refer to raw data reference 27 in "Raw Data Sources" section.

(63) R. L. & L. Environmental Services Ltd. 1999d. Fraser River white sturgeon monitoring program. Region 7 (Omineca-Peace)-1998 Data Report. Draft Report prepared for BC Ministry of Environment, Lands and Parks, Fish and Wildlife Section, Prince George, BC. R.L.&L. Report No. 646F: 26 p.

SUMMARY: The study area for the Region 7 Monitoring Program encompassed the middle and lower sections of the Nechako River fromVanderhoof to the Fraser confluence and the middle section of the Stuart River at Sturgeon Point. A synoptic-level sampling program was conducted in the upper Fraser River mainstem from the Blackwater River to Tete Jaune Cache. Monitoring of radio tagged white sturgeon movements was performed throughout the year. Hardcopy and electronic files available, please refer to raw data reference 27 in "Raw Data Sources" section.

(64) R. L. & L. Environmental Services Ltd. 2000a. Fraser River white sturgeon monitoring program. Region 3 (Thompson-Nicola)-1999 Data Report. Draft Report prepared for BC Ministry of Environment, Lands and Parks, Fish and Wildlife Section, Kamloops, BC. R.L.&L. Report No. 723F: 30 p. + 5 app.

SUMMARY: As in past years of the Fraser River White Sturgeon Monitoring Program, the annual objectives incorporate elements and recommendations from previous studies and discussions with Mr. I. McGregor and other members of the Fraser River sturgeon Technical Committee. The 1999 program was designed to focus on areas of the region with relatively limited white sturgeon distribution and life history information. These areas, including downstream of Hell's Gate and upstream of the Bridge River Rapids, were targeted for two seasons of sampling. In addition, previously sampled areas between Lillooet and Boston Bar were briefly surveyed to refine information.

Mark-recapture (conventional tagging) information was used to monitor the movements of white sturgeon within the study area in 1999. A total of 117 Floy-T-anchor tags were applied and eighteen fish (12.1% of the catch) bearing previously applied Floy tags were recaptured. These previously tagged white sturgeon were recaptured between 0 and 43.8rKm from their original capture location. One white sturgeon was equipped with a radio tag during 1999. Radio tracking efforts were discontinued in 1999, and as such, 1999 movements of sturgeon tagged between 1996 and 1998 were unavailable.

Analysis of life history information revealed a population comprised mainly of younger cohorts of sturgeon less than 15 years-of-age. The length-weight relationship derived for fish captured in 1999 was within the ranges reported in other studies. The population size of white sturgeon in the study area was estimated approximately 1896 fish. The growth rate of white sturgeon was similar those calculated for lower Fraser River populations yet slightly faster than more northern populations. Hardcopy and electronic files available, please refer to raw data reference 27 in "Raw Data Sources" section.

(65) R. L. & L. Environmental Services Ltd. 2000b. Fraser River white sturgeon monitoring program. Region 5 (Cariboo-Chilcotin)-1999 Data Report. Draft Report prepared for BC Ministry of Environment, Lands and Parks, Fish and Wildlife Section, Williams Lake, BC. R.L.&L. Report No. 656F: 24 p.

SUMMARY: In 1999, BC MELP performed all formal field investigations of white sturgeon in Region 5 and commissioned R.L&L to summarize and report their findings. BC MELP sampled

white sturgeon by angling in an area that covered the Fraser River from the French Bar Canyon (rKm 409) to the Cottonwood River confluence area (rKm 670).

Catch-rates differed seasonally and by study section with the highest catch rate recorded during the spring sampling in the middle section. Catches of white sturgeon from the lower section of the study area mainly consisted of juvenile fish that suggested this section was used predominately for rearing purposes. The average fork length of white sturgeon captured in the lower section was under a meter and substantially less than the average length of the catch from the upper sections.

Radio telemetry and mark-recapture (conventional tagging) were used to monitor the movements of white sturgeon in the study area. Twenty-one radio tags were relocated in the study area in 1999 with one of these tags deployed during the present study. Fish movements were mainly localized and several area (e.g., French Bar and Hawks Creek areas, and the Chilcotin confluence) were confirmed as being used for extended periods for feeding and overwintering.

Similar to the results of previous years study, the catch in 1999 consisted of a wide range of size cohorts with smaller classes being most common. The length-weight relationship was within the range reported in other studies in the Fraser River drainage and the size of the population was estimated at 1536 white sturgeon between the French Bar area and Quesnel. Hardcopy and electronic files available, please refer to raw data reference 27 in "Raw Data Sources" section.

(66) R. L. & L. Environmental Services Ltd. 2000c. Fraser River white sturgeon monitoring program. Region 7 (Omineca-Peace)-1999 Data Report. Draft Report prepared for BC Ministry of Environment, Lands and Parks, Fish and Wildlife Section, Prince George, BC. R.L.&L. Report No. 742F: 32 p.

SUMMARY: The intent of the 1999 sampling program was to focus on the spawning and early life history (egg/larval and juvenile rearing) components, and to collect additional information on the life history, distribution, and behavior of the white sturgeon in the Nechako River. Synoptic-level sampling for white sturgeon was conducted in the upper Fraser River mainstem from the West Road (Blackwater) River to upstream of the Morkill River. Monitoring of radio tagged white sturgeon movements was performed periodically throughout the year. Hardcopy and electronic files available, please refer to raw data reference 27 in "Raw Data Sources" section.

(67) R. L. & L. Environmental Services Ltd. 2000d. Fraser River white sturgeon monitoring program- Comprehensive report (1995 to 1999). Final report prepared for BC Fisheries. RL&L Report no. 815F:92 p + app.

SUMMARY: The results of five years of research on white sturgeon in the Fraser River drainage are described according to the study objectives developed in 1995. Five putative populations of white sturgeon were identified in the Fraser River drainage, with four stocks residing in the Fraser River mainstem and a fifth stock documented in the Nechako River drainage.

The lower and middle Fraser River Stocks Groups (SG) of white sturgeon (SG-1 to SG-3) exhibited a wide range of size-classes and maturity cohorts. The density of white sturgeon was determined to be highest in the Lower Mainland section of the Fraser River, with populations generally declining as the geographic range of Stock Group became more northerly. The growth

models showed a slower growth rate and later age-at-maturity for the more northerly stocks; however, evidence was provided that suggested white sturgeon in the lower and middle Fraser River may become reproductively mature at a later age than previously documented.

For all Stock Groups, localized movements were the most common, although larger-scale movements were observed for feeding, overwintering, and spawning. Evidence of white sturgeon movement from the middle to lower Fraser River through Hell's Gate was also gathered that suggested genetic mixing between the stocks.

Indirect evidence of spawning by white sturgeon was documented in the Lower Mainland and Lower Canyon sections of the Fraser River mainstem by the capture of early life history stages. Spawning was considered widespread and occurred during the declining hydrograph in spring, when water temperatures were between 11 and 18°C; spawning was thought to occur in a wide range of habitats. White sturgeon spawning was not confirmed in the middle Fraser River although the capture data suggested white sturgeon may stage or possibly spawn near the Texas and Red Rock creeks, and the confluences of the Nahatlach and Cottonwood rivers.

Although investigations of white sturgeon in the upper Fraser River above Prince George are still in the preliminary stages, information has been collected that suggests the area is mainly used by juvenile and subadult cohorts; their densities are low, with individuals commonly found near the confluences of major tributaries. The growth rate of this Stock Group was slow yet similar to Nechako River sturgeon.

Nechako River sturgeon displayed a population structure that resembled other populations from other regulated systems. The size of the white sturgeon population in the Nechako River was low and comprised mainly of older fish, and the stock exhibited poor spawning success and recruitment. Extensive movements of Nechako River sturgeon for feeding, overwintering, and spawning purposes were generally more common than in other stocks, with some individuals moving between the Nechako and Stuart rivers. Spawning by white sturgeon was not confirmed although results suggested areas such as Isle Pierre, Whitemud, and Hulatt rapids, and the Nautley (Fraser Lake outflow) and lower Stuart river provided suitable spawning habitat and may be used for spawning. The population exhibited late maturation and slow growth, which may be attributable in part to the shorter growing season or to the availability of food sources.

The Stock Groups of white sturgeon in the lower and middle Fraser River each exhibited what appeared to be a population structure that implied successful reproduction and adequate recruitment. However, results suggested that the population of white sturgeon in the Nechako River may be at risk of extirpation. This population will likely require recovery efforts to mitigate impacts and to re-establish a stable, self-sustaining population where future loss of genetic variability is prevented. Hardcopy and electronic files available, please refer to raw data reference 27 in "Raw Data Sources" section.

(68) Richardson, J. S., T. J. Lissimore, M. C. Healey, and T. G. Northcote. 2000. Fish communities of the lower Fraser River (Canada) and a 21-year contrast. Environ. Biol. Fish. 59: 125-140.

ABSTRACT: Fish communities were sampled at 14 sites along the lower 120 km of the Fraser River, British Columbia by beach seine four times in 1972-1983 and three times in 1993-1994. Of the 37 species collected, peamouth chub, largescale sucker, starry flounder and northern squawfish were predominant in either density or biomass. Densities and biomass of most species

and all fish combined was higher in 1993-1994. Strong rank correlations of species abundance or biomass indicated that the overall fish community structure was very similar in both periods. At smaller spatial scales (reaches of 2-3 sites) and shorter time scales (by seasons), less than half the comparisons showed any significant correlation indicating changes in community composition. Largescale sucker, one of the largest contributors to biomass in both periods, showed decreased abundance, i.e. lower density, lower biomass, and large differences in the size-frequency distribution, specifically very low representation of small size classes. Other species, especially small-bodied forms, generally increased in numbers. Despite large changes in the lower Fraser River ecosystem in the past 21 years, the overall fish community has shown remarkably little change over that interval.

(69) Rosenau, M. L. and B. Usher. 1992. Telephone survey to determine attitudes of anglers to proposed changes in non-tidal sturgeon fishing regulations in Region 2, 1992. BC Ministry of Environment Regional Fisheries Report No. LM220. 14 p.

ABSTRACT: Fifty anglers, each holding sturgeon permits from the previous year, were contacted by telephone to determine their attitudes towards proposed and upcoming changes in the 1992/994 non-tidal sturgeon angling regulations in Region 2. The salient regulation changes that will affect sturgeon angler in the Lower Fraser River non-tidal water include: 1) a reduction in the harvest limit from one fish per day , to one fish per year, 2) a change in the harvest slot-size limit for sturgeon which allows the harvest of fish between 1 and 2 metres to fish between 1 and 1.5 metres, and 3) a $5 "tag" or license which will be required by the angler to retain a sturgeon. Previously a free diary card was required to angle for and retain sturgeon. A total of 64% of the respondents had fished for sturgeon in the non-tidal water of the Fraser River in Region 2 in 1991; 70% of these anglers had caught fish while 50% of these anglers had captured at least on legal sized sturgeon (1-2 m). With respect to the question "Would the angler find a reduction in harvest to one fish per year acceptable?", 52% of the respondents agreed while 42% of the anglers did not find this change to be acceptable. All but 2% of the anglers surveyed accepted a reduction in the maximum, size of the fish that me be retained (from 2 – 1.5 m). Finally, the majority of anglers (62%) were willing to pay $5.00 fee to fish for sturgeon.

(70) Roseneau, M. L. 1994. White sturgeon concerns in the lower Fraser River. BC Ministry of Environment, Lands and Parks, Surrey, BC, unpublished report.

SUMMARY: Recent information suggested that white sturgeon populations in the lower Fraser River were declining to levels requiring serious management consideration. This provided BC Environment the initiative for a number of scientific investigations into the life history and fisheries utilization of these fish. It has also stimulated dialogue with and among various management and user groups of the lower Fraser River white sturgeon fisheries including the commercial, sport, and native food-fish sectors. Historically white sturgeon have had considerable social, economic and biological importance to the lower Fraser River and it is the intent of BC Environment to protect white sturgeon from extinction in this part of the watershed. Currently, the white sturgeon has a COSEWIC (Committee on the Status of Endangered Wildlife in Canada) "vulnerable" status and British Columbia Conservation Data Center "S3" rating (rare or uncommon; may be susceptible to large-scale disturbances).

(71) Schubert, N. D. 1984. The Indian food fishery of the Fraser River: 1983 summary. Can. Data Rep. Fish. Aquat. Sci. No. 479: v + 67 p.

ABSTRACT: Weekly effort levels and catches of the five species of Pacific salmon, steelhead trout and sturgeon are reported for 23 fishing areas in the Fraser River Indian food fishery. Regulatory restrictions are summarized for all areas. Hardcopy and electronic files available, please refer to raw data reference 13 in "Raw Data Sources" section.

(72) Schubert, N. D. 1985. The Indian food fishery of the Fraser River: 1984 summary. Can. Data Rep. Fish. Aquat. Sci. No. 512: 64 p.

ABSTRACT: Weekly efforts levels and catches of the five species of Pacific salmon steelhead trout and sturgeon are reported for 23 fishing areas in the Fraser River Indian food fishery. The aggregate salmonid catch of 462,995 was the fourth highest on record. Catch by species totaled 22,784 chinook, 5 pink, 357,529 sockeye, 57,297 coho, 18,635 chum, 6,7454 steelhead and 2,364 sturgeon. The 1984 management plan addressed conservation concerns for early and middle timing chinook and early Stuart sockeye stocks. Hardcopy and electronic files available, please refer to raw data reference 14 in "Raw Data Sources" section.

(73) Schubert, N. D. 1986. The Indian food fishery of the Fraser River: 1985 summary. Can. Data Rep. Fish. Aquat. Sci. No. 560: 80 p.

ABSTRACT: Weekly effort levels and catches of the five species of Pacific salmon, steelhead trout, and sturgeon are reported for 23 fishing areas in the Fraser River Indian food fishery. The aggregate salmonid catch of 563,186 was the highest on record. Catch by species totaled 10,895 chinook, 102,292 pink, 424,499 sockeye, 18,181 coho, 5,859 chum, 1,460 steelhead and 1,112 sturgeon. The 1985 management plan addressed conservation concerns for early and middle timing chinook and early Stuart sockeye stocks. Hardcopy and electronic files available, please refer to raw data reference 15 in "Raw Data Sources" section.

(74) Schubert, N. D. 1992a. Angler effort and catch in the 1985-1988 lower Fraser River sport fishery. Can. Manuscr. Rep. Fish. Aquat. Sci. No. 2170: 140 p.

ABSTRACT: The recreational fishery in the lower 150 km of the Fraser River was assessed using an access point-overflight study design from 1985 to 1988. Over the course of the study, 202 overflights were conducted and 57,124 angler interviews were obtained from 21 sampling sites to estimate monthly angler effort, and the harvest (marked and unmarked) and release by species of salmon (*Oncorhynchus spp.*), trout *(Salmo spp.*), char (*Salvelinus spp.*) and sturgeon (*Acipenser spp.*). This report provides, for four study regions, monthly summaries of interview responses and monthly estimates of angler effort, hourly angler effort profiles, harvest by species and mark type, and release by species.

Annual study period angler effort ranged from 485,931 to 794,658 angler hours. Annual catches (harvest plus release) ranged from 728 to 2,140 chinook adults, 967 to 7,439 chinook jacks, 3,419 to 9,277 coho adults, 5,680 to 20,675 coho jacks, 553 to 1,333 steelhead, 1,637 to 5,560 cutthroat, 223 to 1,459 Dolly Varden and 124 to 556 sturgeon, among other species. Hardcopy and electronic files available, please refer to raw data reference 5 in "Raw Data Sources" section.

(75) Schubert, N. D. 1992b. The 1985-1988 lower Fraser River sport fishery study: Basic catch and effort data by study site. Can. Data. Rep. Fish. Aquat. Sci. No. 886: 140 p.

ABSTRACT: The sport fishery in the lower 150 km of the Fraser River was assessed using an access point-overflight study design from 1985 to 1988. Over the course of the study, 202 overflights were conducted and 57,124 angler interviews were obtained from 21 sampling sites to estimate monthly angler effort, and the harvest (marked and unmarked) and release of salmon (*Oncorhynchus spp.*), trout (*Salmo spp.*), char (*Salvelinus spp.*) and sturgeon (*Acipenser spp.*). This report provides mean monthly angler counts for weekdays and weekends and, for the 25 survey sites, monthly summaries of interview responses and monthly estimates of angler effort, hourly angler effort profiles, harvest by species and mark type, and release by species. The purpose of the report is to serve as a source document in the planning of future studies.

(76) Scott, W. B. and E. J. Crossman. 1973. Freshwater Fishes of Canada. Fisheries Research Board of Canada Bulletin 184: 96-100.

SUMMARY: A brief summary on the description, colour, distribution, biology of white sturgeon in North America. Also included are commercial and sport fishery catch statistics for the Fraser River.

(77) Semakula, S. N. 1963. The age and growth of the white sturgeon (*Acipenser transmontanus* Richardson) of the Fraser River, British Columbia, Canada. MSc Thesis, University of British Columbia, Vancouver, BC , 115 p.

ABSTRACT: Between May 1 and October 28, 1962, growth data were obtained from 255 specimens of white sturgeon (*Acipenser transmontanus*, Richardson) from the Fraser River, British Columbia, Canada. Most of the specimens measuring 36" and over in length were those caught incidentally in the salmon fishermen's nets in the lower part of the Fraser River as far upstream as Langley, British Columbia. Specimens smaller than this length were gill-netted at Dewdney Slough near Mission City, British Columbia.

Age was determined for 230 specimens from sections of the first pectoral rays. Sections from the rest of the materials were unreadable. Growth in length was studied by averaging observed length at capture and relating these to age, and also by back-calculating growth at the different ages of the fish's life. Growth in weight was studied by averaging the observed weights at times of capture and relating these to age and also by calculating weights at different lengths using the length-weight relationship. From the study of growth in length it was revealed that growth in both sexes is similar up to age twenty, but after that age the females grow faster than the males. It is also revealed that neither of the sexes grows to a fixed maximum length. Study of growth in weight revealed a similar pattern until the fish reached 30" but after that the length the females had an advantage over the males.

An attempt was made to determine the age at spawning maturity by relating cessation of growth to the maturation of the gonads. It was found that some males start spawning at age eleven, but females may not spawn until they reach age twenty-five to twenty-seven. Periods between spawnings are variable in the different individuals, but may range from five to ten years.

A study of the mortality rates in the Fraser River white sturgeon revealed that the present fishing mortality rate is excessive. As a result the fishery is now utilizing fish from the young age groups, which may lead to the depletion of stocks. Due to the incidental nature of the fishery it is

not practically possible to introduce measures which would effect a reduction in the fish mortality. It is suggested there be measures which would protect the spawning stocks. These include introduction of a 54" maximum size-limit beyond which length no sturgeon may be taken, complete prohibition of the set-line fishery, and prohibition of sturgeon fishing on the Fraser between Langley and Yale, British Columbia.

(78) Semakula, S. N. and P. A. Larkin. 1968. Age, growth, food and yield of the white sturgeon (*Acipenser transmontanus*) of the Fraser River, British Columbia. Journal Fisheries Research Board of Canada 25(12), :2589-2602.

ABSTRACT: For white sturgeon taken incidentally in the salmon gillnet fishery in the lower Fraser River during the summer of 1962, pectoral fin ray sections indicated that over three-quarters were fish aged 9-16 years. Gillnets for salmon apparently select sturgeon over a size range between 30 and 60 inches. Back-calculation of size attained at previous ages indicated that after attaining a length close to 20 inches by age 5, the sturgeon grow about 2 inches per year to about age 25. Limited data from pectoral fin ray sections suggest that age at first spawning is from 11 to 22 years for males, and from 11 to 34 for females. Subsequent spawning is apparently at intervals of 4-9 years. Fraser River sturgeon are more piscivorous than has been recorded for white sturgeon and the other sturgeon species elsewhere, about one-half of the stomachs containing fish, especially eulachons. The age distribution in the catch, tough biased by selection, was used to estimate rates of natural and fishing mortality. The eumetric fishing curve suggests that present yield could be increased by a greater size at first capture, particularly if the natural mortality rate is as low as 0.05. The history of the sturgeon fishery suggests that sustainable yield could exceed 100,000 lb per year. The commercial landing in recent years average 30,000-40,000 lb. The sport fishery may take an additional 20,000-30,000 lb. Sustained yield in the circumstances of the present fishery could be 80,000 lb per year, about 25% more than the present catch. Some recommendations are made for management, stressing the importance of protection of an annual spawning population of 300-600 females. Some hardcopy and electronic files available, please refer to raw data reference 2 in "Raw Data Sources" section.

(79) Swiatkiewicz, V. J. 1981. Sturgeon management plan for the Lower Fraser (Region 2) and its tributaries. Draft report.

SUMMARY: The objective of this Sturgeon Management Plan is to maintain present stocks by protecting habitat, furthering the knowledge base about the stocks and amending regulations as necessary in the lower Fraser River (Region 2). Management strategies are based on the following facts. There are some glaring information deficiencies that are limiting the scope of Lower Fraser River sturgeon management. Little is known of the early stages of the Fraser River sturgeon and the habitat relationships and dependencies. It is also not known if the harvest (by all fisheries) is impacting on only 1, 2, or 3 different stocks. Finally, the magnitude of the entire harvest of all fisheries has yet to be identified and updated.

(80) Swiatkiewicz, V. J. 1992. Lower Fraser River white sturgeon (*Acipenser transmontanus*) studies from 1985-1987. Regional Fisheries report No.LM209. BC Ministry of Environment. Fish and wildlife Management. Surrey, BC. 40 p.

SUMMARY: The Fraser River white sturgeon fishery on the lower 100 km of river from Hope downstream to the estuary was studied form 1985-1987. This study included both tidal and non-tidal parts of the Fraser. Number of anglers obtaining free non-tidal sturgeon permits increased from 1,100 (1985-86), 1500 (1986-87), to 2000 in 1987/88. In 1986/87, sturgeon anglers fished

5296 days, caught 3951 sturgeon; of which 925 were killed. Most effort and catch occurred from the Mission Bridge (tidal boundary) upstream to the Harrison River. Average size of harvested fish was 121 cm and 18 kg. fifty-four percent (54%) of harvested sturgeon were taken by ten percent (10%) of anglers. A total of 1500 sturgeon in this study area were tagged with Peterson disc tags from 1985 to 1987 and 24 were recovered. Recapture tags were insufficient to obtain a reliable population estimate of the lower Fraser sturgeon population. More tags must be applied and more effort on recoveries is required to increase the degree of reliability of the estimate. Analysis of length frequency catches for the two years indicates 10% mortality of sturgeon between 75-150 cm. Radio tagging of nine sturgeon has yielded sturgeon movement information that is inconclusive.

(81) Veinott, G., T. Northcote, M. Rosenau, and R. D. Evans. 1999. Concentrations of strontium in the pectoral fin rays of the white sturgeon (*Acipenser transmontanus*) by laser ablation sampling-inductively coupled plasma-mass spectrometry as an indicator of marine migrations. Can. J. Fish. Aquat. Sci. 56(11): 1981-1990.

ABSTRACT: Laser ablation sampling – inductively coupled plasma – mass spectrometry (LAS-ICP-MS) was and effective technique for the comparison of relative Sr concentrations in the opaque growth zones (annuli) in the fins rays of white sturgeon (*Acipenser transmontanus*). Three of 20 Fraser River white sturgeon (10.3% of the sample) showed significantly higher Sr fin ray concentrations in at least one annulus compared with the remainder of the fin ray, and this was interpreted as evidence of marine migrations. Eleven other individual fish had significantly higher mean SR concentrations in their first 15 annuli compared with annuli 16-30 but lower than the concentrations of the three putative diadromous fish, and this was interpreted as evidence of time spent in the estuary. Eight Fraser River fish greater than 15 years old showed no significant increase in fin ray Sr concentrations in the first 15 annuli, and Sr concentrations remained below 350 ppm throughout their lives. These individuals were considered likely to have spent most of their lives in a freshwater environment. Based on the evidence in this study, it is probable that the majority of white sturgeon in the lower Fraser River are not diadromous, but many spend extended periods of time in the Fraser River estuary as juveniles

(82) Walter, A. R., V. Palermo, K. J. Scott, and A. S. Thompson. 1998. Angler effort and catch in the 1996 lower Fraser River sport fishery. Can. Manuscr. Rep. Fish. Aquat. Sci. No. 2470: 26 p.

ABSTRACT: The lower Fraser River mainstem recreational fishery was assessed from 1985 to 1988 and again in 1995, using an access point/overflight survey design. From June 6 to August 31, 1996, another recreational fishery survey was conducted on the lower Fraser River using the same study design, but with a new data entry and analysis program. The survey focused on angler effort and the harvest and release of chinook (Oncorhynchus tshawytscha) and sockeye (O. nerka) salmon.

Over the course of the survey, 25 overflights and 4,752 angler interviews were conducted. Angler effort was estimated at 21,205 hours. Total harvests of chinook (adults and jacks combined) and sockeye were estimated at 3,262 and 9,371, respectively. Chinook and sockeye released were estimated at 154 and 8,369, respectively.

The 1996 early season (June and July) chinook catch was down considerably from 1995, due to high water levels. Total August catch for chinook increased from 1995 to 1996, possibly due to high water levels. Total August catch for chinook increased from 1995 to 1996, possibly due to a

greater abundance of chinook in the lower Fraser River during this month. Catch rates for sockeye increased dramatically from 1995 to 1996. Due to high water levels, angler effort in June and July was down compared to 1995. In August, as the water levels dropped and the sockeye fishery opened, angler effort increased considerably, to almost double the 1995 effort. Estimated sturgeon releases for Regions 3 and 4 of the lower Fraser River totaled 36 in June, 23 in July, 138 in August, for a total of 197.

(83) West, G. A. 1968. 1968 Sturgeon Angler Returns. Unpublished reports.

SUMMARY: This report summarizes the results gained from an analysis of questionnaires received from sturgeon anglers and which represent their fishing effort during 1968 on the Fraser River from Mission Bridge to Lillooet. Examining the returns, it was noted that the total catch of under size fish probably was much higher than reported. Several forms listed only legal sturgeon and it is highly doubtful that no sub-legal fish were caught by those reporting several large sturgeon.

It is thought that between 90 and 100 angers fish the Fraser River between Mission bridge and Lillooet. From these figures estimates gained from the 40 returns are 19,536 pounds based on 90 anglers and 21,765 pounds based on 100 anglers. The Indian net fishery catch of sturgeon between Mission and Lillooet is unknown.

(84) West, G. A. 1969. Lower Mainland Sturgeon Report, 1969. Unpublished reports. 5 p.

SUMMARY: This report summarizes a survey which was conducted at the end of 1969 in an effort to learn the total legal catch, the distribution of the catch both in terms of fishermen success and area of catch, the weights of individual legal fish, the size range of the legal fish, and the time of the year at which the fishing pressures were applied. There were 321 legal fish recorded in the returns by the 87 successful (legal) fishermen or an average of 3.7 legal size sturgeon per successful fishermen. The total recorded weight of sturgeon that were caught and kept amounted to 12,964 pounds. This represented only 213 legal size fish of the total of 321. The catch figures indicated that the sturgeon population is in the process of expansion and relatively good numbers of small fish are entering the fishery.

(85) West, G. A. 1970. Lower Mainland Sturgeon Report, 1970. Unpublished reports. 7 p.

SUMMARY: This report summarizes a survey which was conducted at the end of 1970 in an effort to learn the total legal catch, the distribution of the catch both in terms of fishermen success and area of catch, the weights of individual legal fish, the size range of the legal fish, and the time of the year at which the fishing pressures were applied. This is a follow-up of the 1969 survey. The results of both surveys plus the intended one for 1971 will be compiled in a final report at a later date. There were 332 legal fish recorded in the returns by the 96 successful (legal) fishermen or an average of 3.5 legal size sturgeon per successful fishermen. The total recorded weight of sturgeon that were caught and kept amounted to 14,961 pounds. This represented only 215 legal size fish of the total of 332. The total poundage landed was estimated at 19,132 pounds. The catch figures continue to indicate that the sturgeon population is in the process of expansion and relatively good numbers of small fish are entering the fishery.

RAW DATA SOURCES

Commercial Catch Data

(1) Canada (DFO), Catch Statistics Unit, Vancouver, BC. British Columbia Commercial catch statistics, 1953-2000 by species, area and gear type.

Data Source:	Hardcopy and Electronic data
Data Location:	DFO Catch Statistics Unit, Vancouver, BC
Contact Person:	John Davidson, Suzanne Spohn
Data Format:	Hardcopy (1953-1981), Electronic (1982-2000)
Data range (years):	1953-2000
Data Reliability:	Fair

Data Description: This data provides catch of sturgeon in thousands of pounds in the earlier years and then in tons during the later years. Provides information on harvest rates and general indicators of population size.
Recommendations: The commercial catch data for the Fraser River contains harvests of both green and white sturgeon (Jim Echols, John Davidson, pers. comm.). Care should be taken when comparing catch data between years as the data contains mixed species (green and white sturgeon).

(2) Semakula, S. N. and P. A. Larkin. 1968. Age, growth, food and yield of the white sturgeon (*Acipenser transmontanus*) of the Fraser River, British Columbia. Journal Fisheries Research Board of Canada 25(12), :2589-2602.

Data Source:	Journal report
Data Location:	DFO Annacis Island
Contact Person:	Jim Echols
Data Format:	electronic files
Data range (years):	1889-1993
Data Reliability:	Fair

Data Description: Contains electronic data that compares commercial catch statistics by year (1889-1993) for the Fraser River and the Columbia River. Data contains catch statistics for both white and green sturgeon as the sales slips did not separate out the two species.
Recommendations: The commercial catch data for the Fraser River contains harvests of both green and white sturgeon (Jim Echols, pers. comm.). Care should be taken when comparing catch data between years as the data contains mixed species (green and white sturgeon).

(3) Echols, J. 2000. Pers comm. Sturgeon releases in Fraser River Gillnet fisheries via logbooks.

Data Source:	Jim Echols pers. Comm.
Data Location:	DFO Annacis Island
Contact Person:	Jim Echols
Data Format:	Hardcopy
Data range (years):	2000
Data Reliability:	Fair

Data Description: Personal communication from Jim Echols regarding sturgeon releases in Fraser River gillnet fisheries via logbooks in 2000. During the sockeye fisheries a total of 430 sturgeon were released. During the chum fishery a total of 681 sturgeon were released, for a total release of 1,111 sturgeon.

2000 Sockeye fisheries:

July 26-27=25 sturgeon released
August 9-10=89 sturgeon released
August 21-22=316 sturgeon released

2000 Chum fishery:

November 3= 681 sturgeon released

2000 Grand Total:

1,111 sturgeon released from gillnet fisheries in 2000

Recommendations: This data is useful in providing a relative index of sturgeon catch and release in the 2000 Fraser River gillnet fisheries.

(4) J. O. Thomas. 1996-1997. Fraser River selective tooth net fishery data for standard and modified nets.

Data Source:	Electronic data
Data Location:	J. O. Thomas –Vancouver, BC
Contact Person:	Mark Fetterly
Data Format:	Electronic – Excel spreadsheets
Data range (years):	1996 (Sept to Nov); 1997 (Oct-Nov)
Data Reliability:	Poor

Data Description: The 1996 Fraser River selective tooth-net fishery electronic file contains the following data: date (September to November), total fishing time (in minutes), salmon catch (in pieces), sturgeon and other bycatch catch (in pieces), number of sets, average time per set, and catch and effort by statistical week. The 1997 Fraser River selective tooth net fishery electronic file contains the following data: date (Oct-Nov), number of sets, start time of set, total fishing time per standard and modified net, tide change, catch of other species (includes sturgeon in pieces), and catch and effort by statistical week.

Recommendations: The CPUE (catch per unit effort) could be calculated each year and analyzed to see if there are any trends. The CPUE could be compared by year and month for both 1996 and 1997. In addition, the 1997 CPUE could be compared by time of day, set number, and location. A special note should be taken when analyzing the CPUE by year as the total timed fished was not separated by set number in 1996, unlike the 1997 data. The CPUE of the targeted species (salmon) could be compared with the sturgeon CPUE (i.e. Does a high salmon CPUE correlate with a high sturgeon CPUE?). Unfortunately, there is no weight or length data, just presence and absence data.

Sport Catch Data

(5) Inglis, S. D. and M. L. Rosenau. 1994. Non-tidal sturgeon angler fishery on the Lower Fraser River-angler card analysis. Regional Fisheries report LM 241, BC Ministry of Environment, Lands and Parks. 64 p.

Data Source:	Regional MOELP Fisheries Report
Data Location:	DFO Annacis Island
Contact Person:	Marvin Rosenau, Jim Echols (electronic)
Data Format:	Hardcopy and electronic
Data range (years):	1986-1991 (electronic and hardcopy)
Data Reliability:	Good

Data Description: Electronic data for the Fraser River non-tidal sturgeon angler fishery of the Lower Fraser River is available from 1986-1991. This data contains estimates of catch, release, harvest and effort (CPUE and KPUE) for the sturgeon fishery of the Lower Fraser River. Separates sturgeon into size classes.
Recommendations: This data is useful in providing catch and effort data for the 1986-1991 non-tidal sport fisheries on the Fraser River. Additional and more rigorous analyses of catch and harvest could be conducted.

(6) Schubert, N. D. 1992a. Angler effort and catch in the 1985-1988 lower Fraser River sport fishery. Can. Manuscr. Rep. Fish. Aquat. Sci. No. 2170: 140 p.

Data Source:	Manuscript Report
Data Location:	Annacis Island
Contact Person:	Neil Schubert
Data Format:	Electronic and hardcopy
Data range (years):	1985-1988
Data Reliability:	Good

Data Description: Electronic data for the Fraser River tidal sturgeon angler fishery of the Lower Fraser River (Regions 1, 2, and 3) is available from 1985-1988. This data contains estimates of catch, release, and harvest for the sturgeon fishery of the Lower Fraser River.
Recommendations: This data is useful in providing catch and effort data for the 1985-1988 tidal sport fisheries on the Fraser River.

First Nations Catch Data

(7) D.F.O., Annacis Island. 1992-2000 First Nations catch data for the Fraser System.

Data Source:	Electronic data
Data Location:	DFO Annacis Island
Contact Person:	Bridget Enevor
Data Format:	Electronic
Data range (years):	1992-2000
Data Reliability:	Good

Data Description: First Nations catch data for 1992-2000 is summarized weekly by catch (pieces), effort (number of hours fishery is open), and area. A catch per unit effort has not been calculated for this data.
Recommendations: This data provides catch and effort of sturgeon in the Fraser River by river section. Catch per unit effort (CPUE) has not been calculated for this data and it is currently in raw electronic format.

The Indian food fishery of the Fraser River 1983-1991.

Data Source:	Data Report
Data Location:	DFO Annacis Island
Contact Person:	Jim Echols
Data Format:	Hardcopy and electronic
Data range (years):	(electronic file covers years 1983-1991)
Data Reliability:	Excellent

Data Description: Electronic data containing First Nations catch statistics for 1986. Data reported by Catch (pieces), effort (drift net-days, DND), or (set net-days, SND). Catch is broken out into areas within District 2: Steveston, Deas to Mission, Mission to Hope, Hope to North Bend. Catch per unit efforts (CPUE) are calculated within the spreadsheet for the various river sections. Figures are presented which illustrate Catch(pieces) and CPUE (pieces/net day) of sturgeon in the native fishery from 1983-1991. A figure showing relative percentages of catch in the various river sections is also presented. The majority of the sturgeon catch (77%) occurred in the Mission to Hope area.
Recommendations: This data provides catch and effort for the 1986 First Nations fisheries in District 2. The data can also be found in the published report. This data can be used to index catch and effort for the First Nations fisheries over the 1983-1991 period.

Report List

(8) MacDonald, A. L. 1987. The Indian food fishery of the Fraser River: 1986 Summary. Can. Data. Rep. Fish. Aquat. Sci. No. 623: 103 p.

(9) MacDonald, A. L. 1988. The Indian food fishery of the Fraser River: 1987 Summary. Can. Data. Rep. Fish. Aquat. Sci. No. 690: 113 p.

(10) MacDonald, A. L. 1989. The Indian food fishery of the Fraser River: 1988 Summary. Can. Data. Rep. Fish. Aquat. Sci. No. 725: 107 p.

(11) MacDonald, A. L. 1990. The Indian food fishery of the Fraser River: 1989 Summary. Can. Data. Rep. Fish. Aquat. Sci. No. 787: 111 p.

(12) MacDonald, A. L. 1991. The Indian food fishery of the Fraser River: 1990 Summary. Can. Data. Rep. Fish. Aquat. Sci. No. 836: 105 p.

(13) MacDonald, A. L. 1992. The Indian food fishery of the Fraser River: 1991 Summary. Can. Data Rep. Fish. Aquat. Sci. No. 876: 86p.

(14) Schubert, N. D. 1984. The Indian food fishery of the Fraser River: 1983 summary. Can. Data Rep. Fish. Aquat. Sci. No. 479: v + 67 p.

(15) Schubert, N. D. 1985. The Indian food fishery of the Fraser River: 1984 summary. Can. Data Rep. Fish. Aquat. Sci. No. 512: 64 p.

(16) Schubert, N. D. 1986. The Indian food fishery of the Fraser River: 1985 summary. Can. Data Rep. Fish. Aquat. Sci. No. 560: 80 p.

Test Fishery Data

Data for test fisheries on the Fraser River comes from the following sources:

(17) Canada (DFO). Annacis Island. 1980-2000. Albion test fishery data (Chinook).

Data Source:	Electronic data – no report
Data Location:	DFO Annacis Island
Contact Person:	Jim Echols
Data Format:	Electronic – Excel spreadsheets
Data range (years):	1980-2000 (April – October)
Data Reliability:	Good

Data Description: The Albion chinook test fishery electronic file contains the following data: date (April to October), daily fishing time (in minutes), sturgeon catch (in pieces),

mesh type, set number, and year (1980-2000). The 1980-1996 chinook test fishery was based on fishing a two hundred fathom length net of 60 meshes deep or 8" mesh net. In 1997-2000 a multi-panel net was fished alternating every other day with the 8" mesh net. The multi-panel net consists of forty fathoms each of 5", 6", 7", 8" and 9" mesh. In 1999 and 2000 fishing was restricted to every other day with a multi-panel net in September and October. Both the Albion chum and chinook test fisheries occur on the same days during the September and October time periods with their respective nets. The consistency of the data is excellent as the same fishermen has fished these surveys for 20 years.

Recommendations: The CPUE (catch per unit effort) could be calculated each year over the twenty-year span and analyzed to see if there are any trends in abundance (by statistical week, etc.). The CPUE could be compared by year, month, time of day, set number, and gear type. The CPUE of the targeted species (chinook) could be compared with the sturgeon CPUE (i.e. does a high chinook CPUE correlate with a high sturgeon CPUE?). A special note should be taken when analyzing the CPUE by year as the mesh type changed in 1997 which may have changed the catchability of the net. Unfortunately, there is no weight or length data present in order to compare the size range of the sturgeon caught in each mesh type.

(18) Canada (DFO). Annacis Island. 1978-2000. Albion test fishery data (Chum).

Data Source:	Electronic data – no report
Data Location:	DFO Annacis Island
Contact Person:	Jim Echols
Data Format:	Electronic – Excel spreadsheets
Data range (years):	1978-2000 (September to December)
Data Reliability:	Good

Data Description: The Albion chum test fishery electronic file contains the following data: date (September to December), daily fishing time (in minutes), sturgeon catch (in pieces), mesh type, set number, and year (1978-2000). The Albion chum test fishery has always used a 200 -fathom length net, 60 meshes deep or (6.75-inch mesh). Both the Albion chum and chinook test fisheries occur on the same days during the September and October time periods with their respective nets. The consistency of the data is excellent as the same fishermen has conducted these surveys for 22 years.

Recommendations: The CPUE (catch per unit effort) could be calculated each year over the twenty-two year span and analyzed to see if there are any trends. The CPUE could be compared by year, month, time of day, set number, and gear type. The CPUE of the targeted species (chum) could be compared with the sturgeon CPUE (i.e. Does a high chum CPUE correlate with a high sturgeon CPUE?). Unfortunately, there is no weight or length data, just presence and absence data.

(19) Pacific Salmon Commission. 1951-2000[a]. Fraser River Test Fishery (Whonnock).

Data Source:	Hardcopy (electronic data for 2000 only) – no report
Data Location:	Pacific Salmon Commission Library
Contact Person:	Pieter VanWill
Data Format:	Hardcopy (electronic data for 2000 only)
Data range (years):	1951-2000
Data Reliability:	Excellent

Data Description: The Fraser River (Whonnock GY GVB drifts above bridge) test fishing data includes the following: date (June-October), year, statistical area, fisherman, observer, mesh size and net depth, length of net fished (in fathoms), weather (rain, cloud cover, wind), tide condition, fishing time by section (i.e. 0-50 fms, 50-100 fms, and 100-150 fms), catch (in pieces and weight), distribution of fish in net, distance the net drifted, and remarks. All of the Fraser River test fishing data is in hardcopy format only, except for the 2000 data which is in both hardcopy and electronic format. The data from 1951-1991 is not very reliable or consistent, as it was not mandatory to record sturgeon catches on the datasheets. If the sturgeon catches were recorded, the fishermen would indicate the number of sturgeon caught in the remarks section. In several cases approximation of length and weight data were recorded as well. In 1992 the datasheets were redesigned to include sturgeon as one of the primary species caught. Thus, the data would be most reliable from 1992-2000, as it became mandatory to record the sturgeon catch. In 1992 it also became mandatory to record the water temperature of the river. In 1993, the net dimensions changed from the 5 ¼" mesh net (fished consistently between 1970-1992) to a multi-panel mesh (4"- 8 ½") and the length of the net also changed from 150 fm to 175 fm. Prior to 1970, the mesh sized varied (5 ¾", 5 5/8", or 5 ¼") between years. Beginning in 1993, the data recorder also indicated on the datasheets the number of fish snagged rather than gilled in the net. A quick overview of the data reveals the majority of the sturgeon were snagged rather than gilled and girthed. Many of the data recorders have indicated over the years if the sturgeon were released back into the water or sold; however, it is unclear as to the consistency of this data.

Recommendations: The CPUE (catch per unit effort) could be calculated each year over the 49 year span and analyzed to see if there are any trends. Due to the mesh size and length of the net changing over the years special precaution should be taken when comparing the CPUE. The most reliable data would be from 1993-2000 as it was mandatory to record sturgeon catch and the length and mesh size of the net were the same. In 1993, the net dimensions changed to a multi-panel net; therefore, the CPUE could be compared by mesh size throughout the various sections of the net. Unfortunately, there is no weight or length data present in order to compare the size range of the sturgeon caught in each mesh type. However, it could be assumed that the most of the sturgeon caught were large as the majority of the sturgeon were being snagged rather than gilled. An analysis comparing the mesh size versus the number of sturgeon snagged or gilled could be conducted. Overall, this is excellent data and further analyses are recommended.

(20) Pacific Salmon Commission. 1951-2000[b]. Fraser River Test Fishery (Cottonwood).

Data Source:	Hardcopy (electronic data for 2000 only) – no report
Data Location:	Pacific Salmon Commission Library
Contact Person:	Peter Vanwill
Data Format:	Hardcopy (electronic data for 2000 only)
Data range (years):	1951-2000
Data Reliability:	Excellent

Data Description: The Fraser River (Cottonwood) test fishing data includes the following: date (June-October), year, statistical area, fisherman, observer, mesh size and net depth, length of net fished (in fathoms), weather (rain, cloud cover, wind), tide condition, fishing time by section (i.e. 0-50 fms, 50-100 fms, and 100-150 fms), catch (in pieces and weight), distribution of fish in net, distance the net drifted, and remarks. All of the Fraser River test fishing data is in hardcopy format only, except for the 2000 data which is in both hardcopy and electronic format. The data from 1951-1991 is not very reliable or consistent, as it was not mandatory to record sturgeon catches on the datasheets. If the sturgeon catches were recorded, the fishermen would indicate the number of sturgeon caught in the remarks section. In several cases approximation of length and weight data were recorded as well. In 1992 the datasheets were redesigned to include sturgeon as one of the primary species caught. Thus, the data would be most reliable from 1992-2000, as it became mandatory to record the sturgeon catch. In 1992 it also became mandatory to record the water temperature of the river. In 1993, the net dimensions changed from the 5 ¼" mesh net (fished consistently between 1970-1992) to a multi-panel mesh (4"- 8 ½") and the length of the net also changed from 150 fm to 175 fm. Prior to 1970, the mesh sized varied (5 ¾", 5 5/8", or 5 ¼") between years. Beginning in 1993, the data recorder also indicated on the datasheets the number of fish snagged rather than gilled in the net. A quick overview of the data reveals the majority of the sturgeon were snagged rather than gilled and girthed. Many of the data recorders have indicated over the years if the sturgeon were released back into the water or sold; however, it is unclear as to the consistency of this data.

Recommendations: The CPUE (catch per unit effort) could be calculated each year over the 49 year span and analyzed to see if there are any trends. Due to the mesh size and length of the net changing over the years special precaution should be taken when comparing the CPUE. The most reliable data would be from 1993-2000 as it was mandatory to record sturgeon catch and the length and mesh size of the net were the same. In 1993, the net dimensions changed to a multi-panel net; therefore, the CPUE could be compared by mesh size throughout the various sections of the net. Unfortunately, there is no weight or length data present in order to compare the size range of the sturgeon caught in each mesh type. However, it could be assumed that the most of the sturgeon caught were large as the majority of the sturgeon were being snagged rather than gilled. An analysis comparing the mesh size versus the number of sturgeon snagged or gilled could be conducted. Overall, this is excellent data and further analyses are recommended.

General Studies Directed At Sturgeon

(21) Echols, J. C. 1995[a]. Fraser River white sturgeon long-term management: objectives, strategies and uncertainties. Masters Thesis. Dept. Resource and Environmental Studies, Univ. British Columbia, Vancouver, B. C. 87 p.

Data Source:	Masters Thesis
Data Location:	DFO Annacis Island
Contact Person:	Jim Echols
Data Format:	Hardcopy and some electronic files
Data range (years):	1894-1995 summary of info.
Data Reliability:	Good

Data Description: Electronic spreadsheets containing information used in Echols 1995[a] Masters Thesis. The following spreadsheets were supplied by Jim Echols:

Stur growth.xls - This spreadsheets contains growth data (age and weight, and regression chart) for Fraser River white sturgeon. Data was extracted from Semakula and Larkin (1968), Scott and Crossman (1973), Dixon (1986), and MacDonald et. Al (1989).

Stur larv temp.xls – This spreadsheet contains sturgeon larval temperature data showing relationships between timing of white sturgeon embryonic stages and incubation temperatures. Data was extracted from Wang et. al (1985).

Stur mod.xls – This spreadsheet is a delay difference simulation of the white sturgeon fishery. This model was presented in Echols 1995[a] Masters Thesis.

Stur val.xls – This spreadsheet contains landed dollar value, processed value, average price/kg (landed and processed), kilograms sold (landed and processed) and pounds sold (landed and processed). Data from BC Fisheries Statistics, DFO (1959-1989).

Stur tag.xls – This spreadsheet contains tagging data for Fraser River white sturgeon, file contains info on date, site, tag #, fork length, total length, snout length, weight and age data from 1985-1993. Data from Rosenau and Lane. In prep.

Recommendations: This data should be analyzed in more depth.

(22) Fraser River Sturgeon Conservation Society. 1999-ongoing. Sturgeon pit tagging in the Fraser River.

Data Source:	Electronic data
Data Location:	LGL Limited, Sidney, BC
Contact Person:	Troy Nelson
Data Format:	Electronic and hardcopy
Data range (years):	1999-2000
Data Reliability:	Excellent

Data Description: The data base for the ongoing study contains the following information for individual sturgeon sampled: date, capture method, capture location (river kilometer), fork length, girth, scar/wound code, PIT tag number (applied), PIT tag number (recaptured), condition at release (scale, 1-5), and comments. Data for this study is provided through coordinated efforts with First Nations, sport, and commercial fisheries, and directed volunteer efforts, overseen and managed by a biologist/program manager (LGL Limited).
Recommendations: The movement and seasonal migration information that will be available from this study can be compared with parallel data from studies of white sturgeon conducted on the Columbia and Sacramento rivers. Population estimates (by size/age group) and can be compared with population structures of white sturgeon from the lower Columbia River (research conducted by Oregon and Washington).

(23) Perrin, C. J., Heaton, A., and M. A. Laynes. 1999. White sturgeon (*Acipenser transmontanus*) spawning habitat in the lower Fraser River, 1998. Report prepared by Limnotek Research and Development Inc. for B C. Ministry of Fisheries, Victoria, B.C. 53p.

(24) Perrin, C. J., Heaton, A., and M. A. Laynes. 2000[a]. White sturgeon (*Acipenser transmontanus*) spawning habitat in the lower Fraser River, 1999. Report prepared by Limnotek Research and Development Inc. for BC Ministry of Fisheries, Victoria, BC. 53p.

Data Source:	Report
Data Location:	Limnotek
Contact Person:	Chris Perrin
Data Format:	Hardcopy and electronic
Data range (years):	1997-1999
Data Reliability:	Good

Data Description: Electronic files used in the Perrin et. al. 1999 and Perrin et. al. 2000 reports on spawning habitat in the lower Fraser River.
Recommendations: Data already analyzed in report.

(25) Perrin, C. J. 2000. The impact of suction dredging on the abundance of white sturgeon (*Acipenser transmontanus*) and its food resources in the Fraser River at Mission. Report prepared for Mission Valley Shopping Centre Ltd., Vancouver, BC by Limnotek Research and Development Inc., and Cascade Fishing Charters Ltd. 69 p.

Data Source:	Report
Data Location:	Limnotek
Contact Person:	Chris Perrin
Data Format:	Hardcopy and electronic
Data range (years):	1997-1998
Data Reliability:	Good

Data Description: Electronic files used in the Perrin. 2000 report on the impact of suction dredging on the abundance of white sturgeon. Data contains length and weight information for 68 captured sturgeon, as well as, PIT tag information. Catch and effort data is also presented for white sturgeon captured using angling.
Recommendations: Data already analyzed in report.

(26) Perrin, C. J. and E. A. Shaw. 2000. The effect of transfer pit operations on fish, benthic invertebrates and habitat in the Fraser River at Barnston Island, 2000. Preliminary Data Report. Report prepared for Fraser Estuary Management Program, Burnaby, BC, by Limnotek Research and Development Inc. 43 p.

Data Source:	Preliminary Data Report
Data Location:	Limnotek
Contact Person:	Chris Perrin
Data Format:	Hardcopy and electronic
Data range (years):	2000
Data Reliability:	Good

Data Description: Data for 27 white sturgeon includes location captured, tag location, river km, method of capture, weight, length, girth, pit tag number, comments.
Recommendations: This is an ongoing data set that will be useful in determining seasonal migration patterns and movement.

R.L.& L. annual white sturgeon reports 1995-1999

Data Source:	Report
Data Location:	BC Fisheries, Victoria,BC
Contact Person:	Ted Down
Data Format:	Hardcopy and electronic
Data range (years):	1995-1999
Data Reliability:	Good

Data Description: Electronic data for 1995-1999 white sturgeon monitoring program. Database includes, length, weight, sex, age, PIT tag information, capture method, and capture location (MELP region) for 2,057 white sturgeon.
Recommendations: Distributions and seasonal migration of white sturgeon available from this study can be compared with parallel data from other ongoing studies of white sturgeon on the Fraser River.

Report List

(27) R. L. & L. Environmental Services Ltd. 1996. Fraser River white sturgeon monitoring program. 1995 data report. Report prepared for BC Ministry of Environment, Lands and Parks, Fisheries Branch. R.L. &L. Report No. 465F: 6 p. + 5 app.

(27) R. L. & L. Environmental Services Ltd. 1997a. Fraser River white sturgeon monitoring program. Region 2 (Lower mainland)-1996 investigations. Report prepared for BC Ministry of Environment, Lands, and Parks, Fish and Wildlife Section, Surrey, BC. R. L. & L. Report No.524F: 6 p. + 5 app.

(27) R. L. & L. Environmental Services Ltd. 1997b. Fraser River white sturgeon monitoring program. Region 3 (Thompson-Nicola)-1996 investigations. Report prepared for BC Ministry of Environment, Lands, and Parks, Fish and Wildlife Section, Kamloops, BC. R. L. & L. Report No. 536F: 37 p. + 5 app.

(27) R. L. & L. Environmental Services Ltd. 1997c. Fraser River white sturgeon monitoring program. Region 7 (Omineca-Peace)-1996 investigations. Report prepared for BC Ministry of Environment, Lands, and Parks, Fish and Wildlife Section, Prince George, BC. R. L. & L. Report No. 520F: 78 p.

(27) R. L. & L. Environmental Services Ltd. 1998a. Fraser River white sturgeon monitoring program, Region 2 (Lower mainland)-1997 data report. Report prepared for BC Ministry of Environment, Lands, and Parks, Fish and Wildlife Section, Surrey, BC. R. L. & L. Report No.564F: 27 p. + 5 app.

(27) R. L. & L. Environmental Services Ltd. 1998b. Fraser River white sturgeon monitoring program, Region 3 (Thompson-Nicola)-1997 data report. Report prepared for BC Ministry of Environment, Lands, and Parks, Fish and Wildlife Section, Kamloops, BC. R. L. & L. Report No. 563F: 30 p. + 6 app.

(27) R. L. & L. Environmental Services Ltd. 1998c. Fraser River white sturgeon monitoring program, Region 5 (Caribou-Chilcotin)-1997 data report. Report prepared for BC Ministry of Environment, Lands, and Parks, Fish and Wildlife Section, Williams Lake, BC. R. L. & L. Report No. 589F: 32 p. + 6 app.

(27) R. L. & L. Environmental Services Ltd. 1998d. Fraser River white sturgeon monitoring program. Region 7 (Omineca-Peace)-1997 data report. Report prepared for BC Ministry of Environment, Lands, and Parks, Fish and Wildlife Section, Williams Lake, BC. R. L. & L. Report No.565F: 36 p.

(27) R. L. & L. Environmental Services Ltd. 1999a. Fraser River white sturgeon monitoring program. Region 2 (Lower mainland)-1998 data report. Report prepared for BC Fisheries, Surrey, BC and Fraser River Sturgeon Conservation Society. R. L. & L. Report No. 671F: 22 p.

(27) R. L. & L. Environmental Services Ltd. 1999b. Fraser River white sturgeon monitoring program. Region 3 (Thompson-Nicola)-1998 data report. Draft Report prepared for BC Ministry of Environment, Lands, and Parks, Fish and Wildlife Section, Kamloops, BC. R. L. & L. Report No. 659F: 29 p. + 5 app.

(27) R. L. & L. Environmental Services Ltd. 1999c. Fraser River white sturgeon monitoring program. Region 5 (Cariboo-Chilcotin)-1998 data report. Draft Report prepared for BC Ministry of Environment, Lands and Parks, Fish and Wildlife Section, Williams Lake, BC. R. L. & L. Report No. 656F: 28 p. + 5 app.

(27) R. L. & L. Environmental Services Ltd. 1999d. Fraser River white sturgeon monitoring program. Region 7 (Omineca-Peace)-1998 Data Report. Draft Report prepared for BC Ministry of Environment, Lands and Parks, Fish and Wildlife Section, Prince George, BC. R. L. & L. Report No. 646F: 26 p.

(27) R. L. & L. Environmental Services Ltd. 2000a. Fraser River white sturgeon monitoring program. Region 3 (Thompson-Nicola)-1999 Data Report. Draft Report prepared for BC Ministry of Environment, Lands and Parks, Fish and Wildlife Section, Kamloops, BC. R. L. & L. Report No. 723F: 30 p. + 5 app.

(27) R. L. & L. Environmental Services Ltd. 2000b. Fraser River white sturgeon monitoring program, Region 5 (Caribou-Chilcotin)-1999 Data Report. Draft Report prepared for BC Ministry of Environment, Lands and Parks, Fish and Wildlife Section, Williams Lake, BC. R. L. & L. Report No. 656F: 24 p.

(27) R. L. & L. Environmental Services Ltd. 2000c. Fraser River white sturgeon monitoring program. Region 7 (Omineca-Peace)-1999 Data Report. Draft Report prepared for BC Ministry of Environment, Lands and Parks, Fish and Wildlife Section, Prince George, BC. R. L. & L. Report No. 742F: 32 p.

(27) R. L. & L. Environmental Services Ltd. 2000d. Fraser River white sturgeon monitoring program-comprehensive report (1995 to 1999). Final Report prepared for BC Fisheries, Victoria, BC. R. L. & L. Report No. 815F: 92 p. + app.

ACKNOWLEDGEMENTS

The creation of this bibliography was made possible through the contributions and support from many individuals. The authors would especially like to thank Sue Pollard and Ted Down (BC Fisheries) for providing recommendations on the format of this bibliography and guidance throughout its creation. Jim Echols (DFO, Annacis Island) provided several sources of raw data including historic commercial sturgeon catch estimates, First Nations catch data, recreational catch data, Albion test fishery data, and MSc Thesis data. Chris Perrin (Limnotek) also provided several electronic files from Fraser River sturgeon studies. Marvin Rosenau (MELP Surrey) provided a list of white sturgeon references and contacts. Karen Truman (LGL Limited) provided Procite support, Robin Tamasi (LGL Limited) provided the figures for this document, and Cezary Sliwinski (LGL Limited) assisted with data organization and figure presentation.

REFERENCES

Bartley, D. M., G. A. E. Gall, and B. Bentley. 1985. Preliminary desription of the genetic structure of white sturgeon, *Acipenser transmontanus*, in the Pacific Northwest. Binkowski, F. P. and Doroshov, S. I. editors. North American sturgeons: biology and aquaculture potential. Papers from a symposium on the biology and management of sturgeon, held during the 113th annual meeting of the American Fisheries Society at Milwaukee, WI, Aug. 16-20, 1983 , p. 105-109. Dordrecht, Netherlands, Dr. W. Junk Publishers.

BC Ministry of Environment. 1990. White Sturgeon Working Group. Proceedings of the White Sturgeon Working Group meeting, June 20, 1990, Malaspina College, BC, p. 1-12.

BC Ministry of Environment. 1991. White sturgeon (*Acipenser transmountanus*): a management plan for the fisheries program. 18 p. + appendices.

Bennett, W. R., G. Edmondson, E. D. Lane, and M. Rosenau. 1998. Juvenile white sturgeon (*Acipenser transmontanus*) habitat and distribution in the lower Fraser River, downstream of Hope, BC, Canada. Submitted to Can. J. Fish. Aquat. Sci. 23 p.

Bratty, J. M., R. E. Diewert, J. Irvine, V. Palermo, and A. S. Thompson. 1998. Angler effort and catch in the 1995 lower Fraser River sport fishery. Can. Manuscr. Rep. Fish. Aquat. Sci. 2469: 36 p.

Brown, J. R., A. T. Beckenbach, and M. J. Smith. 1992a. Mitochondrial DNA length variation and heteroplasmy in populations of white sturgeon (*Acipenser transmontanus*). Genetics 132: 221-228.

Brown, J. R., A. T. Beckenbach, and M. J. Smith. 1992b. Influence of Pleistocene glaciations and human intervention upon Mitochondrial DNA diversity in white sturgeon (*Acipenser transmontanus*) populations. Can. J. Fish. Aquat. Sci. 49: 358-367.

Brown, J. R., A. T. Beckenbach, and M. J. Smith. 1993. Intraspecific DNA sequence variation of the mitochondrial control region of white sturgeon (*Acipenser transmontanus*). Molecular Biology and Evolution 10(2), :326-341.

Department of Fisheries and Oceans, Annacis Island. 1889-2000 British Columbia Commercial catch statistics .

Department of Fisheries and Oceans, Annacis Island. 1978-2000 Albion test fishery data (Chum).

Department of Fisheries and Oceans, Annacis Island. 1980-2000 Albion test fishery data (Chinook).

Department of Fisheries and Oceans, Annacis Island. 1983-1991 First Nations catch data for the Fraser System.

Department of Fisheries and Oceans, Annacis Island. 1992-2000 First Nations catch data for the Fraser System.

Dixon, B. M. 1986. Age, growth and migration of white sturgeon in the Nechako and upper Fraser Rivers of British Columbia. BC Ministry of Environment, Fisheries Technical Circular No. 70: 27 p.

Echols, J. C. 1995a. Fraser River white sturgeon long-term management: objectives, strategies and uncertainties. Masters Thesis. Dept. Resource and Environmental Studies, Univ. British Columbia, Vancouver, B. C. 87 p.

Echols, J. C. 1995b. Review of Fraser River white sturgeon (*Acipenser transmontanus*). Fraser River Action Plan, Fishery Management Group, and Canada Dept. of Fisheries and Oceans. 33 p.

Echols, J. C. 1995c. Status review of Fraser River white sturgeon (*Acipenser transmontanus*). Draft report. Department of Fisheries and Oceans, Vancouver, BC. 29 p.

ECL Envirowest Consultants Limited. 1990. Fraser River white sturgeon radio tagging and sampling. Progress report to March 31, 1990. Prepared for Ministry of Environment, Fish and Wildlife branch, Surrey, B.C.

ECL Envirowest Consultants Limited. 1992. Fraser River white sturgeon: radio tracking and tissue sampling. 1989-1992. Report prepared for BC Ministry of Environment, Lands and Parks, Surrey, BC, by ECL Envirowest Consultants Ltd., New Westminster, BC. 15 p. + appendices.

Edmonson, G. C., W. R. Bennett, and, and E. D. Lane. 1993. Aspects of age and growth, size distribution, and validation of aging in white sturgeon, *Acipenser transmontanus*, from the Fraser River, British Columbia. Presented at the Proceedings of the 123rd Annual Meeting of the American Fisheries Society. 15 p.

EVS Environment Consultants. 1998. Review of white sturgeon distribution and life history in the Fraser River with respect to potential impacts from sawmill storm water runoff. Report prepared for Coast Forest and Lumber Association, Vancouver, BC by EVS Environment Consultants, North Vancouver, BC. 18 p.

Fraser River Sturgeon Conservation Society. 1999-ongoing. Distribution, seasonal migration patterns, and abundance of white sturgeon in the lower Fraser River.

Glavin, T. 1994. A ghost in the water. New Star Books, Vancouver, BC. 78 p.

Halsey, G., M. Labelle, A. Tautz, and M. Rosenau. 1994. Recovery and restoration of white sturgeon *Acipenser transmontanus* in British Columbia: Fraser and Columbia River watersheds. Report of the White Sturgeon Task Team. 21 p.

Hamilton, G. 1996. Phantom of the Fraser. Canadian Geographic 116(4).

Hanson, D. L., T. G. Cochnauer, J. D. DeVore, H. E. Forner Jr, T. T. Kisanuki, D. W. Kohlhorst, P. Lumley, G. McCabe Jr, A. A. Nigro, S. Parker, D. Swartx, and A. VanVooren. 1992. White sturgeon management framework plan. Pacific States Marine Fisheries Commission. Portland, OR.

Hart, J. L. 1973. Pacific fishes of Canada. Fisheries Research Board of Canada Bulletin 180: 83-84.

Inglis, S. D. and M. L. Rosenau. 1994. Non-tidal sturgeon angler fishery on the Lower Fraser River-angler card analysis. Regional Fisheries report LM 241, BC Ministry of Environment, Lands and Parks. 64 p.

J. O. Thomas and Associates. 1996-1997. Fraser River selective tooth net fishery for standard and modified nets.

Johnston, N. T., L. J. Albright, T. G. Northcote, P. C. Oloffs, and K. Tsumura. 1975. Chlorinated hydrocarbon residues in fishes from the lower Fraser River. Technical Report no. 9. Westwater Research Centre. University of British Columbia, Vancouver, B.C. 31 p.

Laidlaw, K. A. and M. L. Rosenau. 1998. An assessment of putative white sturgeon spawning habitat in areas impacted by scuffle dredging in the Fraser River: Hope to Mission. BC Ministry of Environment Lands and Parks. Regional Fisheries Report No. LM557: 15 p. + appendices.

Lane, E. D. and M. Rosenau. 1995. The conservation of sturgeon stocks in the Lower Fraser River watershed. A baseline investigation of habitat, distribution, and age and population of juvenile white sturgeon (*Acipenser transmontanus*) in the lower Fraser River, downstream of Hope, BC. Final report Habitat Conservation Fund Project. 96 p. + appendices.

Lane, E. D. 1985. A bibliography on the white sturgeon, (*Acipenser transmontanus*) Richardson, 1836. Can. M Rep. Fish. Aquat. Sci. No. 1828: 33 p.

Lane, E. D. 1991. Status of the white sturgeon, *Acipenser transmontanus*, in Canada. The Canadian Field Naturalist 105: 161-168.

Limnotek Research and Development Inc. 2000. Mission project preliminary data.

Lord, J. K. 1866. The naturalist in Vancouver Island and British Columbia. Richard Bentley, London, England, 175-186 p.

Macdonald, A. L. 1987. The Indian food fishery of the Fraser River: 1986 summary. Can. Data Rep. Fish. Aquat. Sci. No. 623: 103 p.

Macdonald, A. L. 1988. The Indian food fishery of the Fraser River: 1987 Summary. Can. Data. Rep. Fish. Aquat. Sci. No.690: 113 p.

Macdonald, A. L. 1989. The Indian food fishery of the Fraser River: 1988 Summary. Can. Data. Rep. Fish. Aquat. Sci. No.725: 107 p.

Macdonald, A. L. 1990. The Indian food fishery of the Fraser River: 1989 Summary. Can. Data. Rep. Fish. Aquat. Sci. No.787: 111 p.

Macdonald, A. L. 1991. The Indian food fishery of the Fraser River: 1990 Summary. Can. Data. Rep. Fish. Aquat. Sci. No.836: 105 p.

MacDonald, A. L. 1992. The Indian food fishery of the Fraser River: 1991 Summary. Can. Data Rep. Fish. Aquat. Sci. No. 876: 86 p.

MacDonald, D. D., M. G. Ikononmou, A. Rantalaine, I. H. Rogers, O. Sutherland, and J. Van Oostdam, 1997. Contaminants in white sturgeon from the upper Fraser River, British Columbia, Canada. Environ. Toxicol. Chem. 16(3), 479-490.

Margolis, L. and T. E. McDonald. 1986. Parasites of white sturgeon, *Acipenser transmontanus*, from the Fraser River, British Columbia. J. Parasit. 72(5), 794-796.

McAdam, S. 1995. Report on the mortalities of Fraser River white sturgeon (*Acipenser transmontanus*) during the summer-fall period of 1993-94. Draft Regional Fisheries Report. 12 p.

McDonald, T. E., E. D. Lane, F. Dalziel, V. J. Swiatkiewicz, and L. Margolis. 1989. Recoveries in 1985 and 1986 and releases in 1986 of tagged Fraser River white sturgeon, *Acipenser transmontanus*, together with data on the numbers of dorsal scutes and number of *Cystoopsis acipenseris* (Nematoda) present on some fish caught in 1986. Can. Data. Rep. Fish. Aquat. Sci. No. 742: 33 p.

McDonald, T. E., V. J. Swiatkiewicz, E. D. Lane, F. Dalziel, and L. Margolis. 1987. Release and recovery data for tagged Fraser River white sturgeon, (*Acipenser transmontanus*), in 1985. Can. Data Rep. Fish. Aquat. Sci. No. 639: 27 p.

Nelson, J., C. Smith, E. Rubidge, and B. Koop. 1999. Genetic analysis of D-Loop region and microsatellite DNA of white sturgeon from British Columbia-population structure and genetic diversity. Unpublished report prepared for BC Fisheries, Conservation Section, Victoria, BC.

Nelson, T. C. 1997. Bowron River white sturgeon inventory 1995-96. Report prepared for BC Ministry of Environment, Lands and Parks, Fish and Wildlife Branch, Prince George, BC, by LGL Ltd., Sidney, BC. 38 p.

Northcote, T. G., N. T. Johnston, and K. Tsumura. 1975. Trace metal concentrations in lower Fraser River fishes. Westwater Research Centre, University of British Columbia, Tehnical Report No. 7: 41 p.

Northcote, T. G. 1974. Biology of the lower Fraser River: a review. Westwater Research Centre. University of British Columbia Technical Report No. 3: 78 p.

Pacific Salmon Commission. 1951-2000a hard data. Fraser River test fishing data at Whonnock .

Pacific Salmon Commission. 1951-2000b hard data. Fraser River test fishing data at Cottonwood .

Palermo, V. and A. S. Thompson. 1999a. Angler effort and catch in the 1997 lower Fraser River sport fishery. Can. Manuscr. Rep. Fish. Aquat. Sci. No. 2488: 24 p.

Palermo, V. and A. S. Thompson. 1999b. Angler effort and catch in the 1998 lower Fraser River sport fishery. Can. Manuscr. Rep. Fish. Aquat. Sci. No. 2469: 31 p.

Palermo, V. and A. S. Thompson. 2000. Angler effort and catch in the 1998 sport fisheries of five lower Fraser River tributaries. Can. Manuscr. Rep. Fish. Aquat. Sci. No. 2530: 55 p.

Parks, N. B. 1978. The Pacific Northwest commercial fishery for sturgeon. Mar. Fish. Rev. 40(7), :17-20.

Perrin, C. J., A. Heaton, and M. A. Laynes. 1999. White sturgeon spawning habitat in the lower Fraser River, 1998. Report prepared by Limnotek Research and Development Inc. for BC Ministry of Fisheries, Victoria, BC. 53 p.

Perrin, C. J., A. Heaton, and M. A. Laynes. 2000a. White sturgeon spawning habitat in the lower Fraser River, 1999. Report prepared by Limnotek Research and Development Inc. for B.C. Ministry of Fisheries, Victoria, B.C. 53 p.

Perrin, C. J. and E. A. Shaw. 2000. The effect of transfer pit operations on fish, benthic invertebrates and habitat in the Fraser River at Barnston Island, 2000. Preliminary Data Report. Report prepared for Fraser Estuary Management Program, Burnaby, BC, by Limnotek Research and Development Inc. 43 p.

Perrin, C. J. 2000. The impact of suction dredging on the abundance of white sturgeon (*Acipenser transmontanus*) and its food resources in the Fraser River at Mission. Report prepared for Mission Valley Shopping Centre Ltd., Vancouver, BC by Limnotek Research and Development Inc., and Cascade Fishing Charters Ltd. 69 p.

R. L. & L. Environmental Services Ltd. 1996. Fraser River white sturgeon monitoring program. 1995 data report. Report prepared for BC Ministry of Environment, Lands and Parks, Fisheries Branch. R.L. &L. Report No. 465F: 6 p. + 5 app.

R. L. & L. Environmental Services Ltd. 1997a. Fraser River white sturgeon monitoring program. Region 2 (Lower mainland)-1996 investigations. Report prepared for BC Ministry of Environment, Lands, and Parks, Fish and Wildlife Section, Surrey, BC. R. L. & L. Report No.524F: 6 p. + 5 app.

R. L. & L. Environmental Services Ltd. 1997b. Fraser River white sturgeon monitoring program. Region 3 (Thompson-Nicola)-1996 investigations. Report prepared for BC Ministry of Environment, Lands, and Parks, Fish and Wildlife Section, Kamloops, BC. R. L. & L. Report No. 536F: 37 p. + 5 app.

R. L. & L. Environmental Services Ltd. 1997c. Fraser River white sturgeon monitoring program. Region 7 (Omineca-Peace)-1996 investigations. Report prepared for BC Ministry of Environment, Lands, and Parks, Fish and Wildlife Section, Prince George, BC. R. L. & L. Report No. 520F: 78 p.

R. L. & L. Environmental Services Ltd. 1998a. Fraser River white sturgeon monitoring program, Region 2 (Lower mainland)-1997 data report. Report prepared for BC Ministry of Environment, Lands, and Parks, Fish and Wildlife Section, Surrey, BC. R. L. & L. Report No.564F: 27 p. + 5 app.

R. L. & L. Environmental Services Ltd. 1998b. Fraser River white sturgeon monitoring program, Region 3 (Thompson-Nicola)-1997 data report. Report prepared for BC Ministry of Environment, Lands, and Parks, Fish and Wildlife Section, Kamloops, BC. R. L. & L. Report No. 563F: 30 p. + 6 app.

R. L. & L. Environmental Services Ltd. 1998c. Fraser River white sturgeon monitoring program, Region 5 (Caribou-Chilcotin)-1997 data report. Report prepared for BC Ministry of Environment, Lands, and Parks, Fish and Wildlife Section, Williams Lake, BC. R. L. & L. Report No. 589F: 32 p. + 6 app.

R. L. & L. Environmental Services Ltd. 1998d. Fraser River white sturgeon monitoring program. Region 7 (Omineca-Peace)-1997 data report. Report prepared for BC Ministry of Environment, Lands, and Parks, Fish and Wildlife Section, Williams Lake, BC. R. L. & L. Report No.565F: 36 p.

R. L. & L. Environmental Services Ltd. 1999a. Fraser River white sturgeon monitoring program. Region 2 (Lower mainland)-1998 data report. Report prepared for BC Fisheries, Surrey, BC and Fraser River Sturgeon Conservation Society. R. L. & L. Report No. 671F: 22 p.

R. L. & L. Environmental Services Ltd. 1999b. Fraser River white sturgeon monitoring program. Region 3 (Thompson-Nicola)-1998 data report. Draft Report prepared for BC Ministry of Environment, Lands, and Parks, Fish and Wildlife Section, Kamloops, BC. R. L. & L. Report No. 659F: 29 p. + 5 app.

R. L. & L. Environmental Services Ltd. 1999c. Fraser River white sturgeon monitoring program. Region 5 (Cariboo-Chilcotin)-1998 data report. Draft Report prepared for BC Ministry of Environment, Lands and Parks, Fish and Wildlife Section, Williams Lake, BC. R. L. & L. Report No. 656F: 28 p. + 5 app.

R. L. & L. Environmental Services Ltd. 1999d. Fraser River white sturgeon monitoring program. Region 7 (Omineca-Peace)-1998 Data Report. Draft Report prepared for BC Ministry of Environment, Lands and Parks, Fish and Wildlife Section, Prince George, BC. R. L. & L. Report No. 646F: 26 p.

R. L. & L. Environmental Services Ltd. 2000a. Fraser River white sturgeon monitoring program. Region 3 (Thompson-Nicola)-1999 Data Report. Draft Report prepared for BC Ministry of Environment, Lands and Parks, Fish and Wildlife Section, Kamloops, BC. R. L. & L. Report No. 723F: 30 p. + 5 app.

R. L. & L. Environmental Services Ltd. 2000b. Fraser River white sturgeon monitoring program, Region 5 (Caribou-Chilcotin)-1999 Data Report. Draft Report prepared for BC Ministry of Environment, Lands and Parks, Fish and Wildlife Section, Williams Lake, BC. R. L. & L. Report No. 656F: 24 p.

R. L. & L. Environmental Services Ltd. 2000c. Fraser River white sturgeon monitoring program. Region 7 (Omineca-Peace)-1999 Data Report. Draft Report prepared for BC Ministry of Environment, Lands and Parks, Fish and Wildlife Section, Prince George, BC. R. L. & L. Report No. 742F: 32 p.

R. L. & L. Environmental Services Ltd. 2000d. Fraser River white sturgeon monitoring program-comprehensive report (1995 to 1999). Final Report prepared for BC Fisheries, Victoria, BC. R. L. & L. Report No. 815F: 92 p. + app.

Richardson, J. S., T. J. Lissimore, M. C. Healey, and T. G. Northcote. 2000. Fish communities of the lower Fraser River (Canada) and a 21-year contrast. Environ. Biol. Fish. 59: 125-140.

Rosenau, M. L. and B. Usher. 1992. Telephone survey to determine attitudes of anglers to proposed changes in non-tidal sturgeon fishing regulations in Region 2, 1992. BC Ministry of Environment Regional Fisheries Report No. LM220. 14 p.

Roseneau, M. L. 1994. White sturgeon concerns in the lower Fraser River. BC Ministry of Environment, Lands and Parks, Surrey, BC, unpublished report.

Schubert, N. D. 1984. The Indian food fishery of the Fraser River: 1983 summary. Can. Data Rep. Fish. Aquat. Sci. No. 479: v + 67 p.

Schubert, N. D. 1985. The Indian food fishery of the Fraser River: 1984 summary. Can. Data Rep. Fish. Aquat. Sci. No. 512: 64 p.

Schubert, N. D. 1986. The Indian food fishery of the Fraser River: 1985 summary. Can. Data Rep. Fish. Aquat. Sci. No. 560: 80 p.

Schubert, N. D. 1992a. Angler effort and catch in the 1985-1988 lower Fraser River sport fishery. Can. Manuscr. Rep. Fish. Aquat. Sci. No. 2170: 140 p.

Schubert, N. D. 1992b. The 1985-1988 lower Fraser River sport fishery study: Basic catch and effort data by study site. Can. Data Rep. Fish. Aquat. Sci. No. 886: 140 p.

Scott, W. B. and E. J. Crossman. 1973. Freshwater Fishes of Canada. Fisheries Research Board of Canada Bulletin 184: 96-100.

Semakula, S. N. and P. A. Larkin. 1968. Age, growth, food and yield of the white sturgeon (*Acipenser transmontanus*) of the Fraser River, British Columbia. Journal Fisheries Research Board of Canada 25(12), :2589-2602.

Semakula, S. N. 1963. The age and growth of the white sturgeon (*Acipenser transmontanus* Richardson) of the Fraser River, British Columbia, Canada. MSc Thesis, University of British Columbia, Vancouver, BC , 115 p.

Swiatkiewicz, V. J. 1981. Sturgeon management plan for the Lower Fraser (Region 2) and its tributaries. Draft report.

Swiatkiewicz, V. J. 1992. Lower Fraser River white sturgeon (*Acipenser transmontanus*) studies form 1985-1987. Regional Fisheries Report No. LM209. BC Ministry of Environment. Fish and Wildlife Management, Surrey, BC. 40 p.

Veinott, G., T. Northcote, M. Rosenau, and R. D. Evans. 1999. Concentrations of strontium in the pectoral fin rays of the white sturgeon (*Acipenser transmontanus*) by laser ablation sampling-inductively coupled plasma-mass spectrometry as an indicator of marine migrations. Can. J. Fish. Aquat. Sci. 56(11), :1981-1990.

Walter, A. R., V. Palermo, K. J. Scott, and A. S. Thompson. 1998. Angler effort and catch in the 1996 lower Fraser River sport fishery. Can. Manuscr. Rep. Fish. Aquat. Sci. No. 2470: 26 p.

West, G. A. 1968. 1968 Sturgeon Angler Returns. Unpublished reports.

West, G. A. 1969. Lower mainland sturgeon report, 1969. Unpublished reports. 5 p.

West, G. A. 1970. Lower Mainland sturgeon report, 1970. Unpublished reports. 7 p.

APPENDIX A. Summary of locations, contacts, and information gathered for the Fraser River white sturgeon document.

Location	Contact/phone number	Information gathered
Carrier/Sekani Tribal Council	Marcel Shepert 250-562-6279	Left messgae- no response.
Department of Fisheries and Oceans Annacis Island, BC	Melanie Sullivan 604-666-2417	Albion Test Fishery data from 1980-2000.
Department of Fisheries and Oceans Vancouver	Sandy Argue 604-666-8192 (Van.) 250-472-0475 (Vic.)	Additional contacts, sources of information.
Department of Fisheries and Oceans Annacis Island, BC	Neil Schubert 604-6668452	
Department of Fisheries and Oceans Annacis Island, BC	Bridget Ennevor 604-666-6608	All native catch stats in electronic tabular form from 1992-2000.
Department of Fisheries and Oceans Annacis Island, BC	Jim Echols 604-666-2370	Albion test fishery data (1978-2000). First nations catch data (1983-1992). Commercial catch data (1889-1991). Recreational catch data (1986-1991). Msc. Thesis data
Fraser River Port Authority New Westminister, BC	Dean Chalcraft - 250-524-6655	Habitat assessment for MELP (Marvin Rosenau)

Location	Contact/phone number	Information gathered
Fraser River Sturgeon Conservation Society Vancouver, BC	Troy Nelson 604-535-1768	Fraser River white sturgeon pit tagging-ongoing.
J.O. Thomas Vancouver, BC	Mark Fetterly 604-291-6340	Fraser River catch data, additional contacts.
Limnotek Research and Development Inc. Vancouver, BC	Chris Perrin - 604-222-3546	White sturgeon spawning habitat in the lower Fraser (3 reports)
Malaspina College/University Nanaimo, BC	Gordon Edmondson 250-753-3245	Additional contacts.
Malaspina College/University Nanaimo, BC	Dr. David Lane 250-755-8764	Additional contacts.
MELP - Surrey	Marvin Rosenau- 604-582-5312	Sturgeon authority on the lower mainland - has library of sturgeon references
MELP - Surrey	Vic Swaitkiewicz - 604-582-5218	Pesticides and heavy metals (4 reports)
MELP - Kamloops	Rob Bison 250-371-6244	Additional contacts.

Location	Contact/phone number	Information gathered
Pacific Biological Station Nanaimo, BC	Dr. Chris Wood - 250-756-7140	Committee Supervisor for Christian Smith at UVIC
Pacific Biological Station Nanaimo, BC	Ray Lauzier - 250-756-7023	Works on Columbia and Kootney River sturgeon
Pacific Salmon Commission Vancouver, BC	Teri Tarita - 604-684-8081	Whonnock and Cottonwood test fishery data
Pacific Salmon Commission Vancouver, BC	Peter Vanwill - 604-684-8081	Whonnock and Cottonwood test fishery data
Seastar Biotech Victoria, BC	John Nelson - 250-727-6111	Works with Christian Smith at UVIC (currently doing reports for MELP
Special Collections Library - UBC Vancouver, BC	George Brandak-604-822-2232	Old BC Packers data
Sport fishing guide	Clarence McIvor 250-256-7355	Sturgeon sport catch. Left message-no response.
UBC - Biological Sciences	Dr. Don McPhail - 604-822-0216	
UBC- retired	Dr. Thomas	Westwater reports

Location	Contact/phone number	Information gathered
faculty Summerland, BC	Northcote 250-494-8463	
University of Victoria Victoria, BC	Christian Smith - 250-472-4072	Doing Masters Thesis on sturgeon genetics in the lower Fraser. Working with John Nelson to do contract work for MELP.
W.B. and M.H. Chung Library	Rachel Grant (librarian)	References from the book called
Vancouver Maritime Musueum	604-257-3099	"A Ghost in the Water".